Guidance for Reclamation and Reuse of Municipal and Industrial Wastewater

Idaho Department of Environmental Quality

December 2005

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Organization of This Internet Version of the Reuse Guidance

The Web-based electronic reuse guidance is topic driven. Interested viewers may click on the topic of their choice in the table of contents for access to the latest guidance information. Other internal links within the topics allow viewers to move between topics on a limited basis.

Additionally, this will be the location in the Reuse Guidance that will outline the sections that have been modified in the past two years.

Date	**Brief description of modifications**	**Sections modified**
12/15/2005	Specific revisions to sections 1, 6.3, and 7, including creation of overall guidance Preface from introductory passages of Section 1; division of guidance into Parts A (slow rate land treatment of wastewater), B (high rate land treatment of wastewater), and C (other reuse); addition of reuse templates supplementary information for Section 1, addition of guidance index.	1, 6.3, 7

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Preface

Note: Department of Environmental Quality (DEQ) guidance does not have the force of law or regulation, nor does not it replace best professional judgment; it provides a starting point and assistance in the design of wastewater reclamation and reuse programs.

Introduction: From Land Application to Reuse

Land application involving land treatment of wastewater has long been recognized as a viable method of wastewater treatment, but, in some cases, it became apparent that surface and ground water contamination related to the wastewater land treatment system operation was occurring. Moreover, experience and a better understanding of how ground water contamination is related to activities on the land surface has raised awareness of the complexity surrounding land treatment methods. These and other issues were the driving forces in developing a wastewater land application permit program in Idaho.

The broader topic of *reuse* of wastewater, introduced in this version of the guidance, includes many other uses besides land treatment and land application. The future direction of the Land Application Permit Program will be to include these additional uses and to periodically update the rules and guidance as needed to address the demand.

Wastewater Land Application Permit (WLAP) Program History

The Wastewater Land Application Permit (WLAP) Program is an established and well developed state regulatory program. Together, the regulations and guidelines have helped establish parameters for workable land application permits that protected surface and ground water quality and met the treatment needs of the wastewater generator.

1988: Introduction of the Original Guidelines

The original program regulations became effective in April 1988, and the companion guidelines were finalized in March 1988. The 1988 guidelines were of necessity very general, focusing on broad considerations for both the design and evaluation of WLAP proposals. Five years into program implementation, however, it became apparent that some program components required more specificity for the second generation of permits to be issued in a fair and consistent manner, while still allowing flexibility for site specific conditions. Also, significant technical changes had been made regarding distances to public or private wells and ground water monitoring, and these changes needed to be made available to the permittee. The 1994 *Technical Interpretive Supplement* (described immediately below) made these technical advances available to the regulated community in addition to the 1988 guidelines.

1993: Expansion of the Original Guidelines

A WLAP technical work group, comprising agency, industry, municipalities, and technical consultants, was formed in September 1993 to expand the original guidelines on four (4) selected issues of concern. The expansion, called the 1994 *Technical Interpretive Supplement*, included-supportive information on the following:

- Growing and non-growing season application rates
- Capture zone analysis and wellhead protection to determine minimum setback distances to public and private wells
- Buffer zones to protect the public
- Grazing on land application sites

Both the 1994 *Technical Interpretive Supplement* and the 1988 guidelines support and reinforce laws and regulations, but, by themselves, are not standards or mandates. Both were published in April of 1996, as a combined paper document called the *Handbook for Land Application of Municipal and Industrial Wastewater*.

2002: Development of New Guidance and Increased Internet Posting

In 2002, a significant amount of new guidance was developed for the reuse program, and more use was made of the Internet to provide this guidance to the public, the regulated community, and to DEQ internally. The inclusion of the new guidance was part of the continuing effort to ensure consistency in the reuse program and to involve public participation.

An effort to post all draft and final permits on the Internet was also initiated in 2002, and this effort will continue in the future to make the public and the permittees more aware of the directions of the program and to make permits more consistent across the state.

It is the intent of the program to use the Internet to continually update information and guidance via the DEQ Web site. Input from the public at large is welcome.

2004: Creation of the Web-Based Guidance

DEQ initiated a renewed public participation process in 2004 to provide for a consistent review of existing guidance and to establish a process for introducing and examining new guidance. With regard to this guidance, DEQ invited the public to form an advisory working group that would meet periodically to review existing and future reuse guidance, providing suggested updates, additions, deletions, or corrections.

DEQ intends to post the suggestions from this group on its Web site for a 30-day public comment period. Following that public comment period, the advisory working group will review public comment, modify the suggested changes if needed, and then submit the final suggested modifications to the Director of DEQ for a final decision on including them in the Reuse Guidance Document.

The advisory working group is open to the public at large and can introduce new suggested guidance to DEQ through its workings.

In May of 2004, DEQ created an electronic Web-based draft, which was simply a reorganization, by topic, of the *Handbook for Land Application of Municipal and Industrial Wastewater*, calling it the *Guidance for Land Application of Municipal and*

Industrial Wastewater. Since that time, DEQ has sought continued public input to update and make corrections to this initial Web-based document.

2005: Expansion of Scope to Include Reuse

As a part of the public process, and in anticipation of a name change from the *Wastewater Land Application Permit Rules* to *Reclamation and Reuse of Municipal and Industrial Wastewater Permit Rules* (*Reuse Rules*), the name of this guidance is now ***Guidance for Reclamation and Reuse of Municipal and Industrial Wastewater (Reuse Guidance)***. This name change will embrace future uses of reclaimed wastewater that may or may not have anything to do with land treatment or land application.

Current and Future Directions for the Reclamation and Reuse of Municipal and Industrial Wastewater

The *Reuse Rules* (IDAPA 58.01.17) apply to both new systems and existing systems:

- New systems must be designed to meet all requirements of the *Reuse Rules*. The *Reuse Guidance* provides assistance to meet the requirements of the rule, and should be used, therefore, by new systems to ensure compliance.
- Existing systems must meet the requirements of the rules and their permit. When a permit comes up for renewal, then the system must meet the requrements of the latest *Reuse Rules*. If a permittee has been experiencing operational or compliance problems with meeting permit conditions or water quality standards, the reuse guidance should be reviewed in order to help attain compliance.

In summary, the *Reuse Rules* address the treatment of municipal and industrial wastewater by different types of land application and treatment systems and other treatment requirements for higher classes of effluent.

Locations of the Rules

Applicants for reuse permits can find the applicable rules at the following locations:

- The *Reuse Rules* (IDAPA 58.01.17) can be located at the following address:

  http://adm.idaho.gov/adminrules/rules/idapa58/0117.pdf

- The *Ground Water Quality Rule* (IDAPA 58.01.11), which has impact on reuse facilities, is located at the following address:

  http://adm.idaho.gov/adminrules/rules/idapa58/0111.pdf

- The *Water Quality Standards and Wastewater Treatment Requirements* (IDAPA 58.01.02) can be located at the following address:

  http://adm.idaho.gov/adminrules/rules/idapa58/580102.pdf

Opportunities to Comment on This Guidance

The *Reuse Guidance* is intended to be a dynamic information source, evolving as new technology becomes available or expanding as additional issues of concern are researched and developed. Given this focus on adapting to change, DEQ is interested in receiving comments on any issue that should be considered for future editions of this document.

Comments, suggestions, or issues of concern may be submitted to:

Department of Environmental Quality
1410 N. Hilton
Boise, Idaho 83706-1255
Attention: Richard Huddleston, Program Manager
Wastewater Program

Part A: Slow Rate Land Treatment of Wastewater

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1. Preparing a Reuse Permit Application for Wastewater Land Treatment

A reclaimed wastewater reuse permit (reuse permit) is required to modify, operate, construct, or discharge to a reuse facility. The application of wastewater to land for treatment (wastewater land application) is one type of reuse. This section provides information on the process of applying for a *land treatment* reuse permit.

> **Note:** Read this section if you are applying for a reuse permit application for the treatment of municipal or industrial wastewater by application to land.
>
> If you are preparing a reuse permit application for other direct uses of municipal reclaimed wastewater—such as toilet flushing, dust control, or Class A wastewater treatment—see Part C, Section 12 of this guidance.

1.1 Required Information

The *Reuse Rules* (IDAPA 58.01.17) specify information required in a reuse permit application. In addition, application processing procedures are outlined in the reuse rules.

Other requirements for land application projects can be found in the following:

- Section 600 of the *Water Quality Standards and Wastewater Treatment Requirements Rules* (IDAPA 58.01.02) specifies requirements for the land application of wastewater (Note – this will be changed to *Wastewater Rules* (IDAPA 58.01.16) in 2006).
- The *Ground Water Quality Rule* (IDAPA 58.01.11) specifies necessary ground water quality requirements.

Applicants are strongly encouraged to review these rules to become familiar with these requirements (links to these rules are provided in the introduction to this document), before the pre-application form submittal and conference.

> **Note:** See *Locations of the Rules*, in the Preface of this document, for information about locating the rules that apply to reuse.

1.2 Definitions

The following definitions apply to this section:

- *Major* permit modifications are those, which if granted, could result in an increased hazard to the environment or to the public health.

- *Minor* permit modifications are those, which if granted, would not result in any increased hazard to the environment or to the public health. Minor modifications are normally limited to the correction of typographical errors, transfer of ownership or operational control, or a change in monitoring or reporting frequency.

1.3 Steps in the Application Process

The three major steps in preparing a land treatment reuse permit application are listed below. These steps pertain to applying for a new permit, a renewal permit, a permit modification (minor or major), or to request a permit waiver.

1. Pre-application form submittal
2. Pre-application conference
3. Reuse permit application submittal.

Step 1. Pre-Application Form Submittal

The first step in preparing a reuse permit application is to submit the Reuse Permit Pre-Application Form and the Facility Basic Information Form, both of which can be downloaded from the following address:

http://www.deq.idaho.gov/Applications/WLAP/instructions.cfm

These Web-based forms should be completed and electronically submitted to a Water Quality Manager in the DEQ Regional Office in which the project is located. For a list of regional Water Quality Managers, see the following:

http://www.deq.state.id.us/about/regions/regional_managers.cfm#water

The Reuse Permit Pre-application Form should identify the type of application (new, renewal, major modification, minor modification, waiver request) and provide contact information. The Facility Basic Information Form is used to identify the types of waste, type of facility, types of reuse, approximate volume of wastewater, legal location, county, and description of the land application process.

By submitting these forms, the DEQ Regional Office is notified that the applicant is initiating the reuse permit application process.

Step 2. Pre-Application Conference

Before submitting a reuse permit application, it is highly recommended that a pre-application conference be held between the applicant and DEQ. For a new site, or if DEQ staff involved have not recently visited an existing site, consider scheduling a short site visit as part of the conference.

If you are applying for a minor permit modification or a permit waiver, contact the Regional DEQ Office to discuss your project prior to scheduling the pre-application conference. It is possible that the detailed information outlined in the remainder of this section does not pertain to your situation.

If you are applying for a waiver, you should know that waivers from the requirements of the Reuse rules may be granted by DEQ on a case-by-case basis upon full demonstration by the applicant that:

- The waiver will not have a detrimental effect upon existing water quality, and uses are adequately protected, and
- The treatment requirements are unreasonable with current technology or economically prohibitive.

For all other types of reuse permit applications (new, renewal and major modification), the applicant and DEQ may consider the more detailed pre-application conference process presented below.

A. In preparation for the pre-application conference, it is recommended that *DEQ*:

1. Review the pre-application form submitted by the applicant.
2. If an existing site, and if time allows, review the permit file prior to the conference:
    a. Determine the status of compliance activities in the current permit.
    b. Review recent annual reports regarding: hydraulic and constituent loading rates, results of monitoring efforts, and other operating issues identified in the reports or through DEQ review of the reports.
    c. Review available site inspection reports.
    d. If applicable, review existing legal agreements, such as Consent Orders or a Notice of Violation (NOV).

B. In preparation for the pre-application conference, it is recommended that the *applicant* consult the "Suggested Outline for Preparing the Technical Report" and the "Guidelines for Preparing the Site Maps" (presented in Section 1.6), assemble as many materials and maps as is practical, and be as prepared as possible to discuss the items listed in the suggested outline.

Items recommended for discussion between the applicant and DEQ during the pre-application conference are listed below. For some applicants, the pre-application conference may be a preliminary inquiry and more than one conference may be necessary.

1. Have the applicant describe their proposal in detail.
2. Discuss scheduling issues:
    a. For a new site, discuss when the applicant proposes to begin land application activities.
    b. For an existing site, discuss the timeframe for any proposed changes to land application activities.
3. Discuss the ownership of the land application site. If not owned by the applicant, discuss the need for providing a lease or rental agreement.

4. Review the *Vicinity Ma*p and *Facility Site Map* (see Section 1.6) prepared for the pre-application conference. Discuss site topography, potential buffer zone issues, and other potential site constraints. Discuss what is recommended to be added to these maps for purposes of the reuse permit application submittal.
5. Review *Site Limitation Rating Criteria for Land-Applied Wastewater* (Table 2-1) and discuss site specific characteristics.
6. Discuss recommended sampling and analysis efforts to be performed for the purposes of preparing the reuse permit application. These efforts may include additional sampling of the land applied wastewater, site soils, site groundwater, and/or other sampling and analysis important for site characterization.
7. Discuss the need (and, if appropriate, a schedule) for seepage rate testing of wastewater structures or ponds.
8. Discuss local permits and approvals that may be required (conditional use permit, planning and zoning requirements, other agency approvals…).
9. Determine if the land application site will be leased or operated by a third party. If a third party is involved, a signed contract or agreement will be required regarding third party responsibilities for operating the site under the conditions of the permit.
10. For renewal permits, discuss if an updated Plan of Operation and/or updates of other site management plans should be submitted with the reuse permit application.
11. Review the *Suggested Outline for Preparing the Technical Report* section below and the materials assembled by the applicant for the pre-application conference. Discuss what additional information is recommended to be included with the Reuse permit application.
12. Discuss the overall steps and schedule for the permit process (refer to Section 1.8).

Step 3. Wastewater Reclamation and Reuse Permit Application Submittal

The reuse permit application submittal, at a minimum, should contain the items listed below.

- *Reuse Permit Application Form*: This form must be submitted with the signature of the owner or an authorized agent.
- *Technical Report* (suggested outline is presented below).
- *Site Maps* (described at the end of this section).
- *Plan of Operation Checklist*:
    - Existing facilities are required to have a plan of operation, which describes in detail the operation, maintenance, and management of the wastewater treatment system. An up-to-date Plan of Operation should be available for DEQ review as part of the reuse permit application.
    - For new facilities, a general outline of a plan of operation should be submitted.

1.4 Reuse Permit Application Form

A copy of the Application for Wastewater Reuse Permit can be found in the Appendix, Section A.12.

1.5 Suggested Outline for Preparing the Technical Report

A suggested outline for preparing the Technical Report is provided below. Depending upon the facility, the outline below may be reduced or, alternatively, expanded upon. For a renewal permit or a permit modification, the outline may be greatly reduced if previously submitted items are still representative of the applicant's activities.

I. Site Location and Ownership

A. Site Location

1. Describe the location of the wastewater treatment facility and, if different, the location of the land application site.
2. Describe relative locations of important land features (cities, roads…) to the treatment facility and land application site.
3. Describe adjacent land uses and identify distances from the boundary of the land application site(s) to the following buffer objects: dwellings, areas of public access, canals/ditches, private water sources, and public water sources.

B. Site Ownership

1. Identify who owns the land application site. If not owned by the applicant, describe any pertinent leases or agreements in place.
2. Within this section, or referring to an appendix, provide the following documentation:
   a. Land Application Site Ownership: provide documentation of site ownership for areas of land application.
   b. If the applicant is leasing or renting the land application site, provide an affidavit stating the specifics of the water use agreement or lease stating the actual control over the property.
   c. Provide copies of any other agreements affecting the ownership and/or operation of the site (right-of-way easements, for example).
   d. List all local, state, and federal permits/licenses/approvals related to the land application facility. For each, list the date(s) of application, the current status, and, if applicable, the approval date. Include any required planning and zoning approvals and/or required conditional use permits.

II. Process Description

A. Process Flow Description

1. Identify the sources of wastewater. Describe any seasonal variations in the wastewater (quantity and quality).
2. Describe the flow path of wastewater from the wastewater source to the land application site.
3. Identify the major treatment steps (equipment) of the wastewater treatment facility. For municipal systems, describe the disinfection treatment system and the proposed level of disinfection.
4. Identify sizes and design capacities of major equipment.
5. Identify the flow design basis. For existing sites, present recent wastewater flow data.
6. If applicable, describe any alternate treatment methods being considered.
7. Describe procedures that would be followed if the principal wastewater treatment procedures could not be used temporarily.
8. Identify sources and types of generated waste solids.

B. Land Application Site

1. Identify the number of land application acres.
   a. If applying for a new permit, identify the proposed number of land application acres.
   b. If applying for a renewal permit or permit modification: 1) list the current hydraulic management units and associated acres and 2) describe any proposed changes to the land application acreage.
2. Identify the type(s) of irrigation system(s) (pivot, hand lines,…) and the corresponding irrigation efficiency(ies).

III. Site Characteristics

A. Site Management History

1. Describe past and current uses and management of the land application site including: important events and dates, cropping information, historic fertilizer use, and other key past and current site management information.

B. Climatic Characteristics

1. Describe the climatic characteristics of the site including precipitation data, high and low temperature data, frost free days, growing degree days, and prevailing wind direction.

C. Soils

1. Describe site soils. Present Natural Resource Conservation Service (or similar) soil survey information and results of any on-site investigations.
2. Present and interpret available soil monitoring results.
3. If wastewater land application in the non-growing season is proposed, calculate and present the available water holding capacity of the soils.

D. Surface Water

1. Identify and describe the location of surface water(s) near the land application site.
2. As applicable, discuss canals, wetlands, springs, floodplains, and other surface water related site characteristics including beneficial uses.
3. Describe, as appropriate, the influence of site land application activities on nearby surface water(s).

E. Groundwater/Hydrogeology

1. Describe the groundwater system, including: depth to first water, depth to regional groundwater, confined or unconfined (if known), flow direction (if known), and seasonal depth and flow direction variations. If applicable, describe the presence of a major aquifer.
2. Discuss the locations and uses of wells (public wells, private wells, monitoring wells, and injections wells) within ¼ mile of the land application site. Include copies of well logs, if available. The IDWR (Idaho Department of Water Resources, www.idwr.state.id.us) may be contacted for assistance.
3. If a Well Location Acceptability Analysis has been performed for the site, present and interpret results of the analysis.
4. Present and interpret available groundwater monitoring results (upgradient and downgradient of the land application site) and/or on-site investigations.
5. Present and interpret results of any groundwater modeling efforts for the site.

IV. Wastewater Characterization, Cropping Plan, and Loading Rates

A. Wastewater Characterization

1. Identify the quantity of land applied wastewater (per day, per month, per year). Document how the quantity values were determined.

2. Characterize the concentrations of key constituents in the wastewater proposed for land application. Document how the concentration values were determined. Basic constituents of interest are: total nitrogen, total phosphorus, and Chemical Oxygen Demand (COD). Depending on the wastewater source, concentrations of other constituents may be important. For industrial systems, concentrations of total dissolved inorganic solids (TDIS) and/or metals may be pertinent. For municipal systems, total coliform counts may be presented.

B. Cropping Plan

1. Describe proposed crop selection and a 5-year rotation plan.
    a. For each crop, describe: planting and harvesting data, irrigation sensitivity, rooting depth, expected yield (compare to yield data published by the Idaho Department of Agriculture (see Section 7), and expected crop uptake values for key constituents in the wastewater.
    b. For each crop, calculate and present the Irrigation Water Requirement (IWR). Document how the IWR value(s) were determined.
    c. If proposing to utilize wastewater for tree irrigation, present a silvicultural plan (a plan covering the care and cultivation of the trees).
2. Describe the proposed future use of fertilizers at the site. Document nutrient loading associated with fertilizer use.

C. Hydraulic Loading Rate

1. Present the expected wastewater hydraulic loading rates by month for growing season and non-growing season.
2. Describe the availability of supplemental irrigation water for the site and whether or not supplemental irrigation water is expected to be used at the site. Provide documentation that water rights exist to provide supplemental irrigation. If expected to be used, present the typical supplemental irrigation water hydraulic loading rates for potential crops.
3. Discuss irrigation scheduling for the site.
4. If storage of wastewater is proposed, prepare and present a monthly water balance for the storage structure(s) reflecting: number of days of storage, required freeboard, minimum depth, evaporation, precipitation, and flows into and out of the structure.

D. Constituent Loading Rates

1. Calculate and present the expected growing season and non-growing season loading rates for key constituents. If waste solids and/or fertilizers are proposed to be applied to the land application site, reflect the application of these materials in site constituent loading rate calculations.
2. Compare expected constituent loading rates to applicable crop uptake values for the site.
3. Identify the design limiting constituent.

V. Site Management

A. Compliance Activities

1. If applying for a permit modification or a renewal permit, provide a summary and status of compliance activities under the existing permit.

B. Seepage Rate Testing

1. Discuss the need (and, if appropriate, a schedule) for seepage rate testing of wastewater structures or ponds.

C. Site Management Plans

If the site has previously developed any of management plans listed below (or other site specific plans), either separately or as part of the site Plan of Operation, provide any updates to the information presented in the plan(s). If a new site, or if the plans have not been developed for an existing site, address each of the plan topics.

1. *Buffer Zone Plan*:
    a. Discuss disinfection and buffer zone issues for the land application site. Address the following buffer objects: dwellings, areas of public access, canals/ditches, private water sources, and public water sources.
    b. Compare site buffer distances to DEQ guideline buffer distances. As applicable, describe any proposed mitigation measures to potentially reduce the required buffer distances.
    c. Describe current and/or proposed fencing and signing for the facility.
2. *Grazing Management Plan*: required if any grazing activities are proposed at the land application site.
3. *Nuisance Odor Management Plan*: for systems with higher strength wastewater (wastewater with a greater potential to create odors), it is highly recommended that a Nuisance Odor Management Plan be prepared as part of the permit application.
4. *Waste Solids Management Plan*: discuss whether or not solids are to be applied on the permitted reuse site. If so, reflect the application of waste solids in site constituent loading rate calculations. If waste solids are managed off-site, refer to IDAPA 58.01.02, Section 650 regarding sludge usage.
5. *TDIS (Total Dissolved Inorganic Solids) Management Plan*: to address potential increases in TDS (total dissolved solids) concentrations in groundwater and/or excessive salt levels in soils.
6. *Runoff Management Plan*: to address best management practices for minimization of runoff and ponding.

D. Monitoring

1. Describe how the quantity of land applied wastewater is proposed to be monitored (methodology, frequency, location).
2. Describe proposed sampling and analysis of the land applied wastewater (constituents, disinfection level, methodology, frequency, location).
3. Describe method of calculating hydraulic and constituent loading.
4. If supplemental irrigation water is expected to be used, describe how the quantity of land applied supplemental irrigation water is proposed to be monitored (methodology, frequency, location).
5. Describe proposed soil monitoring (constituents, soil depths, methodology, frequency, location).
6. Describe proposed groundwater monitoring (constituents, methodology, frequency, location).
7. Describe how crop uptake values are proposed to be determined (plant tissue monitoring, table values…).
8. Describe other proposed monitoring for the site.
9. Describe meteorological monitoring for site.

E. Site Operations and Maintenance

1. Describe who will operate and maintain the wastewater treatment facilities and land application site.

2. Describe operator certification credentials—credentials currently held and any plans for future certifications.
3. If a party other than the applicant operates and maintains the land application site, submit a copy of the signed contract or agreement outlining how the site will be operated to meet the conditions of the permit.

1.6 Guidelines for Preparing the Site Maps

If helpful for ease of preparation and/or use, the information listed under Vicinity Map and Facility Site Map may be divided between more than two maps. The maps may be included as an appendix in the technical report.

1.6.1 Vicinity Map

The Vicinity Map is a topographic map, extending one quarter (1/4) mile beyond the outer limits of the facility site. As required in the *Reuse Rules* (IDAPA 58.01.17), identify and show the location and extent of the following:

- Property boundaries of all treatment facilities and land application area(s). Include Township(s), Range(s), Section(s).
- Wells, springs, wetlands, and surface waters.
- Public and private drinking water supply sources and source water assessment areas (public water system protection area information).
- Public roads.
- Dwellings and private and public gathering places.

1.6.2 Facility Site Map

The *Facility Site Map* is a topographic map. As required in the *Reuse Rules* (IDAPA 58.01.17), identify and show the location and extent of the following:

- Wastewater inlets, outlets, and storage structures and facilities.
- Wells, springs, wetlands, and surface waters.
- Twenty-five (25), fifty (50), and one hundred (100) year flood plains, as available through the Federal Insurance Administration of the Federal Emergency Management Agency.
- Service roads.
- Natural or man-made features necessary for treatment.
- Buildings and structures.
- Process chemicals and residue storage facilities.

In addition, the following items are recommended to be identified on the Facility Site Map:

- Land application area(s).
    - For an existing site, identify the permitted hydraulic management units, including serial number, and clearly show any proposed changes to the land application acreage.
    - For an existing site, identify the soil monitoring units, including serial number.
- For an existing site, include serial numbers for lagoons/storage ponds (if applicable).
- Wastewater and site monitoring points, including groundwater monitoring wells (if applicable).
- Quantify and label buffer zone distances between the land application area(s) and: dwellings, areas of public access, canals/ditches, private water sources, and public water sources.

1.6.3 Other Site Specific Maps and Drawings

Present other pertinent maps or drawings for the site. These may include:

- Groundwater contours and direction of flow.
- Wastewater treatment facility drawings.
- Irrigation system design drawings showing sumps, pipelines, ditches, irrigation diversions, irrigation systems (pivots, wheel lines, etc.), and other relevant items.
- Location and extent of run-on and/or run-off control systems including berms and tailwater collection systems.
- Other maps important for presenting site characteristics and/or site operations.

1.7 Plan of Operation Checklist

A copy of the Plan of Operation Checklist can be found in the Appendix, Section A.12.

1.8 Reuse Permit, Permit Process Steps

Procedures and timing for processing reuse permit applications are outlined in the *Reuse Rules* (IDAPA 58.01.17). Applicants are encouraged to review the rules to become familiar with these procedures. (See the Preface to this guidance for links to the rules affecting reuse.)

1.8.1 Typical Steps for a Reuse Permit

Typical steps associated with obtaining a reuse permit from DEQ are as follows:

Pre-application form submitted to the DEQ Regional Office.

4. Pre-application conference between the applicant and DEQ.

5. Applicant submits a reuse permit application to the DEQ Regional Office.
6. DEQ performs a completeness review. Typically, at this step, DEQ also makes a preliminary decision regarding whether or not to issue a permit.
7. DEQ prepares a *Staff Analysis* and *Draft Permit* for the complete application.
8. DEQ issues a draft permit. This step includes review of the draft permit and staff analysis by DEQ's state program office and the DEQ Director. The draft permit and staff analysis are posted on the DEQ internet site.
9. Comments may be submitted by the applicant and by the public. In some cases, meetings are held between DEQ and the applicant to discuss the draft permit. Also, if appropriate, public information meetings may be held.
10. DEQ prepares responses to comments and prepares the final permit. If substantial modifications are made to the permit, they are reviewed with the DEQ Director.
11. DEQ issues final permit. The applicant may appeal the final permit, if desired.

1.8.2 Reuse Permit Application Timing

The reuse rules specify the following timing for submitting a reuse permit application:

- At least one hundred eighty (180) days prior to the day on which a new activity is to begin;
- At least one hundred eighty (180) days prior to the expiration of any permit issued pursuant to these rules;

To meet this requirement, applicants are encouraged to plan ahead. Some applicants may need to allow six months or more for preparing the permit application *prior* to submittal. Examples for which additional time may be required include the following:

- Applying for a new permit.
- Applying for a major permit modification.
- Applying for a renewal permit when major changes to land application activities are to be addressed with the renewal permit.

If you are applying for a minor permit modification, discuss the scope and timing of the modification application with the DEQ Regional Office. For example, it may not be possible to foresee a transfer of ownership 180 days prior to the change. Requests for changes in the permit processing procedure are addressed by DEQ on a case-by-case basis.

For guidance on preparing a *Reuse Permit Application* for the other uses of municipal reclaimed wastewater that do not involve land treatment, see Part C of this Guidance.

1.9 Reuse Permit Templates

Permit templates used by DEQ, for both municipal and industrial reuse applications, are provided in the Appendix, Section A.11.

Permit templates used by DEQ, for both municipal and industrial reuse applications, are provided in the Appendix, Section A.11.

2. Site Evaluation, Selection, and Management

When considering the use of land to treat wastewater, a number of concepts should be considered. The soil crop system must be used to treat the wastewater to prevent problems related to ground and surface water pollution and nuisance situations. The use of land for disposal only of the wastewater generated from a facility is not acceptable. Land based systems must be evaluated as a treatment, not disposal mechanism. Every effort should be made to apply wastewater at a rate and manner that will allow the soil crop system to assimilate the wastewater constituents such that minimal amounts leave the site through leaching or runoff.

The physical characteristics of a proposed wastewater treatment site must be evaluated as part of the site selection screening process. This process must keep in mind the characteristics and volume of the wastewater. These considerations will help determine the limiting factors associated with the proposed site.

This section provides numerical guidelines for site evaluations for environmental, management, and sociological factors where possible. It should be noted that exceptions can be made in many cases but the wastewater generator must supply adequate information to establish a reasonable operation plan. It is the intention of DEQ to work with the wastewater generator to meet their needs in a reasonable way while still protecting the waters of the state.

2.1 Environmental Factors

Initial site evaluation is an important step in determining the potential an area might have for the treatment of wastewater. This general investigation can provide good background for further evaluation and prevent possible costly detailed site reviews. Environmental factors to evaluate include climate, soils, topography, geology and hydrogeology. A detailed discussion of the needs of the soil crop treatment system is included in these guidelines and can also be helpful in initial site evaluation.

2.1.1 Climate

Idaho has a wide range of climates which affect temperature, growing season and evapotranspiration. These climatic factors may determine, to a greater or lesser extent, crop or vegetation to be used on site, the amount of storage which may be necessary for wastewater, and the amount of natural precipitation that must be considered for site and system design. These climatic factors also help determine evapotranspiration and evaporation rates during each season and management considerations for operation and maintenance of the site.

A site evaluation includes obtaining specific information related to local temperature ranges to determine the growing season and trends in precipitation levels. The necessary considerations related to temperature are the length of the growing season and the period of freezing conditions. Low temperatures affect the capacity of the soil crop system to effectively treat wastewater during the winter months and must be evaluated on a case-by-case basis. Temperatures range from an average of 53 degrees F in the Boise area to less than 44 degrees F in the mountains including the higher mountain valleys. The growing season, where temperatures remain above 32 degrees F, can range from 135-165 days in the Boise area to less than 80 days in high mountain regions. The evaporation rate from open water ranges from 40 inches in southern Idaho to 26 inches in some of the high valleys during the growing season.

The levels of precipitation in Idaho range from 6 inches to nearly 80 inches in some higher mountain areas of the northern part of the state. It should be recognized that in Idaho the precipitation is generally highest when temperatures are at their lowest, but in most cases, precipitation in Idaho is low.

Analysis of rainfall data should be conducted in terms of quantity and seasonal distribution. Types of precipitation data usually required for site suitability considerations for wastewater application and treatment include: total mean annual precipitation, maximum annual precipitation, mean monthly precipitation, maximum ten year storm event, and the effects of snow on year round application systems.

Other climatic factors that may be considered in site selection are prevailing winds and wind velocity. The prevailing winds can have an important effect on site selection (see Section 2.1.2 below) See Section 4 for further discussion of precipitation with respect to crop needs and hydraulic loading.

2.1.2 Soil

Idaho has a wide range of climates, geologic, topographic and natural biological conditions that affect the kind of soil that is formed. There are almost 1,000 different kinds of soil in Idaho. Soils differ in their response to use and management, are unique to positions in the landscape and may be different over a short distance.

The solid matrix of soils consists of sand, silt, clay and organic matter. Because of their small relative surface area, the sand and silt elements are essentially nonreactive. These soil textures provide a relatively rigid framework containing the clay and organic matter but by themselves function largely as a physical filter. On the other hand, the clays and organic elements of the soil matrix are extremely reactive, thus determining the treat ability of wastewater by soils.

For general site evaluation, published or unpublished soil surveys are useful. Published soil surveys are usually made under the leadership of the Soil Conservation Service, and are available through the Soil Conservation Service, Extension Office, Soil Conservation Districts, or the BLM District Office. Unpublished mapped areas may be available through the local office of the Soil Conservation Services or the BLM District Office. For the land that is under the jurisdiction of the USDA Forest Service, soils maps may be available through the local Forest Service Office. The General Soil Maps for Idaho, 1984, are also useful for potential site location.

On-site soils descriptions and investigations should be made of sites that have been selected. The description should be made by a soil scientist, preferably a Certified Professional Soil Scientist. The soil description should include information to determine the suitability of the soil to adequately treat the wastewater. The characteristics of wastewater will dictate the kinds of soil characteristics that will be required. Sometimes it is useful to have the soil classified according to *soil taxonomy* (USDA-SCS, 1984).

Typically the description should include: texture of different horizons, estimated organic matter of the surface and in some cases subsurface horizons, horizon thickness, color, structure and pH. Nutrient status of the soil, including plant available nitrogen and phosphorus, is also important. Other factors include depth and characteristics of the underlying bedrock or limiting layer, natural soil drainage, permeability of the least permeable layer, depth to seasonal water table, and soil slopes. Descriptions of other soil characteristics may be needed like infiltration rate, cation exchange capacity, kind of clay, available water capacity, kind and amount of coarse fragments, soil temperature and moisture regimes, salinity, sodium adsorption ratio, flooding potential, soil erodibility factors, wind erodibility factors, coatings of oxides, sesquioxides, zones of carbonate accumulation, and for loose sand and gravel the percent of different sizes of the fractions. The importance of these descriptions will depend on the characteristics of the wastewater which is to be treated.

There are many factors related to the above discussions important to land treatment of wastewater. The table below gives a physical characteristic rating for the potential suitability of a site for wastewater treatment. These characteristics need to be evaluated when considering a site for wastewater application. There are some characteristics not listed that may need evaluation for some unique kinds of a rating of very severe in any of the major factors in the Table 2-1 may make the site unacceptable unless it can be reasonably shown that it will not create any significant environmental impact. The rating of severe does not mean that a potential site is not usable, but may be one of the limiting characteristics, when combined with others, may make the site unusable. On the other hand, a rating of slight does not mean that a site will function properly if other site conditions are severe or the system is mismanaged.

The rationale for criteria of particular importance in the table below are discussed here. Sites that have limiting layers or consolidated bedrock at less than five feet have a potential for hydraulic overloading when high volumes of water are applied. The high salt content of the soil in relation to that of the wastewater can limit treatment and be detrimental to the hydraulic conductivity of the soil. Sites with steep slopes have an increased potential for runoff and erosion which may cause off site damage. Slope will affect the type of application system and site management.

Sites with cryic (cold) soils have a shorter season of use and the biological activity of these soils is lower during the cold season affecting the efficiency of wastewater treatment. Sites with short frost free seasons have a shorter period of use and may indicate a need for storage or larger area for application during cold months.

Sites with soils containing carbonates, oxides and certain sesquioxides will more readily fix phosphates, and heavy metals. Heavy metals are less mobile in soils within a pH range of 5.6 to 7.9 and generally mobilize in soils with a pH value of 5.6 and below. Soils that contain high volumes of coarse fragments have less reactive surface area for wastewater treatment. Application areas may need to be designed larger to adequately treat the wastewater.

Sites with surface textures of sandy loam, slit loam and loam have better tillage characteristics than soils with higher clay contents. Site management is more critical for sites with high clay content. Also infiltration and permeability rates decrease as clay content increases. Sites with soils that have too rapid or too slow permeability (see the table below) have lower wastewater treatment potential. Soils with rapid permeability can allow wastes to travel through the root zone without adequate treatment. Those that have slow permeability will increase the size of the area needed to prevent hydraulic overloading.

Maintenance of the soil organic matter is important in that it provides a host of soil microbes, has exchange complexes to hold pollutants, and aids in maintaining good soil physical conditions. See Section 7 for further discussion on soils.

Table 2-1. Site Limitations Rating Criteria for Land-Applied Wastewater.

Site Characteristics	Very Severe	Severe	Moderate	Slight
AWC in/60 in. (Available Water Capacity	<1"	1 - 3"	3 - 6"	>6"
Bedrock Characteristics if >5' depth		Highly Fractured Columnar	Fractures 1 - 2' apart	Fractures >2' apart
Cation Exchange Capacity (Surface 10")	<5 meq/100gr	5 - 10 meq/100gr	10 - 20 meq/100gr	>20 meq/100gr
Coarse Fragment (>3") (0-40" depth)	>60%	35 - 60%	15 - 35%	<15%
Depth of Bedrock	<2'	2 - 3'	3 - 5'	>5'
Drainage Class	Very Poorly Excessive	Poorly Somewhat Poorly Somewhat Excessive	Moderately Well	Well
Erodibility (Water) K Factor X slope	>6	4 - 6	2 - 4	<2
Flooding Potential	More than once per year	Every 1 - 2 years	Every 2 – 5 years	> Every 5 years (none)
Frost Free Season[2] (32 F)	<60 days	60 - 90 days	90 – 120 days	>120 days
Limiting Layer Depth (duripan) (fragipan)	<3'	3 – 4'	4 - 5'	>5'
Organic Matter (0-10" depth)	<0.5%	0.5 - 1%	1 – 3%	>3%
Permeability (Slowest layer within 5' depth)	>20" per/hr <0.06" per/hr	10 - 20" per/hr 0.06 - 0.2" per/hr	6 - 10" per/hr 0.2 - 0.6" per/hr	0.6 - 6" per/hr
pH 0-40" depth	<4 >9	4.0 - 4.5 8.5 - 9.0	4.5 - 5.6 7.9 - 8.5	5.6 - 7.9
Salinity 0 - 40-" depth	>8 mmhos/cm	4 – 8 mmhos/cm	2 - 4 mmhos/cm	<2 mmhos/cm
SAR (Sodium Adsorption	>12	8 - 12	4 - 8	<4

Site Characteristics	Very Severe	Severe	Moderate	Slight
Ratio)				
Slopes %[1]	>12	6 - 12	2 - 6	<2
Soil Texture Surface	Clays >50% Extremely Gravelly Textures, Stony Soils, Very & Extremely Cobbly	Clays, Silty Clays, Cobbly Soils, Very Gravelly Textures	Silty Clay Loams, Clay Loams, Gravelly Textures, Sandy Clay Loam, Sands	Sandy Loams Silt Loams Loams
Soil Temperature Regime			Cryic	Frigid or warmer
Soil Moisture Regime		Aquic	Aquic Intergrade	Xeric Udic Aridic
Subsurface Structure 3-24" depth		Massive Platy Columnar	Weak Blocky Weak Prismatic	Mod & Strong Blocky Mod & Strong Prismatic
Surface Structure 0-10" depth cultivated 0-3" depth, native		Cloddy Massive Platy	Weak Granular Weak Blocky	Mod & Strong Granular, Mod & Strong Blocky
Water Table Depth	<2'	2 - 3'	3 - 5'	>5'
Wind Erodibility Group (SCS)		6, 7, 8	1, 2	3, 4, 4, <5

[1] Land that is established in forests can be acceptable in the very severe range.
[2] Summer application can be considered if classified very severe.

2.1.3 Topography

The topography of the site is also important to the site selection and management. The more level topography present, the fewer difficulties in the construction, operation and maintenance of a land treatment system. Potential land treatment sites which have a slope of less than 2% are considered to be the most suitable. As slope increases so does the potential for erosion and runoff. It also is harder to evenly distribute the wastewater. Sites with slopes above 8% are severely limited and may not be acceptable for wastewater application without special care in both design and operation. Erosion and runoff potential increases as slope of the site increases.

Southerly and westerly slopes receive higher amounts of solar energy. Plants start growing earlier in the spring and have a potential of less frost damage from light frosts in the spring and fall. Sites in low pockets with higher adjacent areas may have a higher potential for cold air accumulation and potential frost damage. North and east slopes usually accumulate more snow. Snow accumulations on these positions last longer and result in somewhat shorter growing season. Toe slope positions accumulate water from higher elevation and potentially have higher moisture and possible high water tables.

2.1.4 Geology and Hydrogeology

The geologic factors are important in evaluating a site for land application of wastewater since the treated or partially treated wastewater that moves beyond the soil column will enter the underlying geologic zone and ground water. Figure 2-1 shows aquifer types in Idaho.

The degree to which a given lithologic unit acts as a barrier (aquiclude) or transmitter (aquifer) depends on its porosity and permeability. Fracturing due to rapid contraction at the surface while cooling is characteristic of igneous rocks and generally of high water yielding formations such as the Snake Plain Aquifer. Any geologic unit which may be a source of drinking water or for uses requiring high quality ground water will have to be evaluated carefully to understand the potential contamination problems that could result. For example, the nature of the bedrock beneath the land treatment site should be evaluated if the soils are shallow or don't have the necessary textural qualities.

Geologic factors of the site that should be considered include the characteristics of the ground water including depths, kinds (confined or unconfined), flow direction, rate of flow and quality of water. The presence or absence of a major aquifer should also be considered. Depth to and thickness of limiting layers may effect the usefulness of the site as they affect the mounding potential of water below the site. Bedrock depth, kind and characteristics (i.e., fractured, weathered, solid, dense, tilt or slope) of underlying unconsolidated material (including sediments, alluvium, gravel and sand) should also be considered, along with any other characteristics of the vadose zone that effect movement of water. The potential for ground water contamination is greater if a site has highly fractured bedrock at less than five feet. The potential for contamination is greater in sites with water tables at less than five feet. See Section 7 for further discussion of ground water.

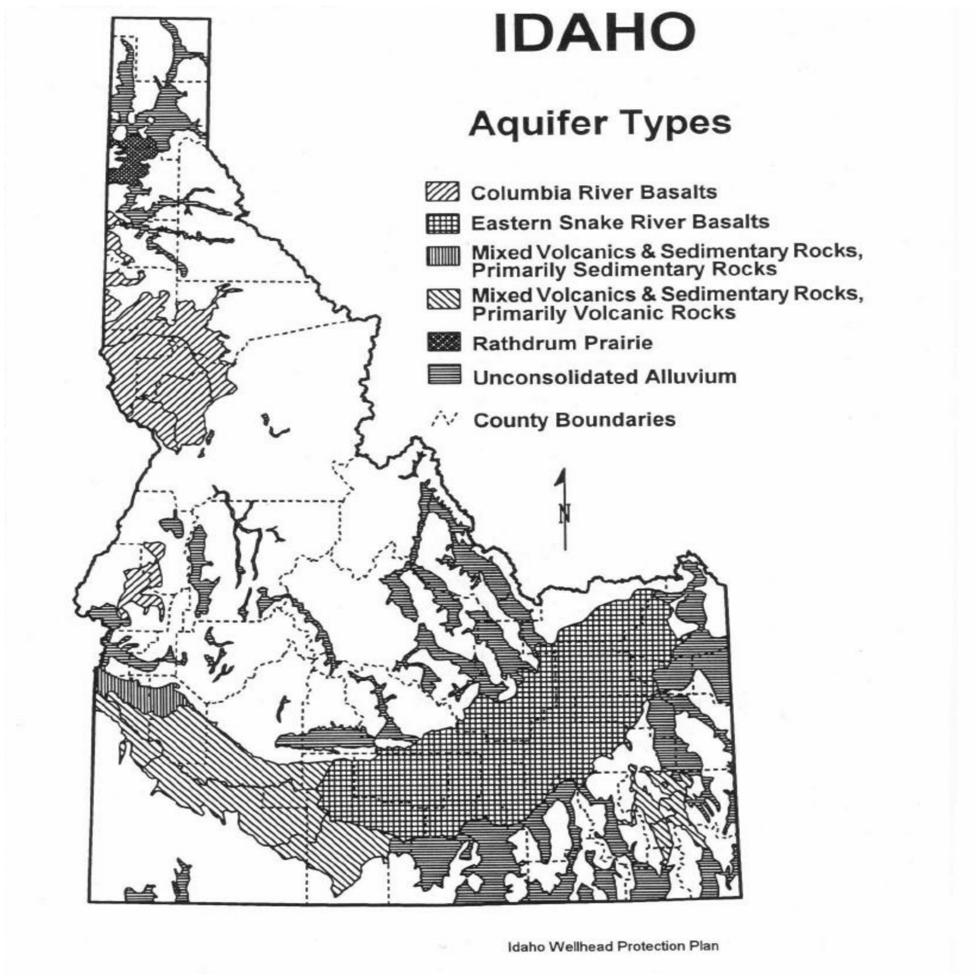

Figure 2-1. Map of Major Aquifers in Idaho.

2.2 Wastewater Characteristics

Constituent and hydraulic loading considerations are important to the evaluation of a site for land application of wastewater. Any one of these factors can be potentially limiting depending on other site characteristics. Several factors should be considered to determine if land-application can be used as a wastewater treatment method. Detailed discussions of constituent loading are found in Section 4.

2.3 Crop Management

The science of site management can be very complex. The operator must be well qualified and take in consideration the waste materials, soil site conditions, climatic conditions, vegetation management and economics. Site management may be the most critical link in the overall operation of the facility. An individual site can have the best soils and a proper design, but will likely fail if adequate site management is not practiced. This will require a procedure to periodically review and update the management plan.

The establishment and maintenance of the vegetation cover and crop is important. In order to reuse and remove nutrients applied from wastewater land treatment, the crop must be harvested and removed from the treatment site. Harvesting operations should be conducted when soil moisture conditions are below field capacity. If a site is mismanaged and the vegetation dies, the site will not be as effective in treating the wastewater. Plant or crop selection is very important in the operation plan. However, if the wastewater characteristics change from the original plan there may be a need to change the plant or crop. Over application of N can cause accumulation of nitrate in plant tissue. Cattle poisoning can result from feeding forages with levels exceeding about 2,000 ppm nitrate as N.

Some sites do not remove all harvested material and may need additional consideration of nutrient losses. This is particularly important with silvicultural sites where significant nutrients are returned to the system if slash is not removed at harvest time. Silvicultural plans (or plan updates) for forest/tree sites are required at approximately five-year intervals. These plans should be prepared by a qualified silviculturist and describe necessary management techniques and recommend harvest cycles. Plans should include the following items: 1. Use of long-term, forest management principles; 2. Minimization of surface water flow by proper irrigation scheduling and maintaining vegetative cover. 3. Maintenance or enhancement of water quality; 4. Maximization of productivity of the forest resource, and 5. Protection of the forest resource from insect, disease, and fire hazards. These items for inclusion are taken from the Garfield Bay Forest Management Plan prepared by Inland Forest Management, Inc. in 1995.

2.4 Sociological Factors and Land Use

Sociological factors must be taken into account when evaluating suitability of wastewater land application proposals. Planning and zoning is discussed as well as considerations relating especially to nuisance conditions.

2.4.1 Planning and Zoning Requirements

Chapter 65, Title 67, Idaho Code grants authority for comprehensive land use planning to local government. Contact the local city or county Planning and Zoning (P&Z) authority for zoning permits, conditional use permits and building permits; flood plain and storm water run-off requirements; and other types of planning requirements such as landscaping requirements for both new, expansions or remodels to existing facilities. Some P&Z departments may require a conditional use permit for the wastewater-land application system separate from the facility's zoning permit for the site. Some P&Z authorities may also act as the coordinator for approvals coming in from various agency inspectors on such issues as plumbing, electrical and fire codes.

An evaluation of the surrounding land uses must take place as part of determining the acceptability of the site by the community. The present land use should be evaluated in site selection. The planned use of the site should not conflict with the present or planned uses of adjacent property. Land uses that need to be considered in site evaluation include proximity of municipal wells and wells for domestic use, proximity of homes, and proximity of other installations and industry that have the potential for impacts on ground water or air quality such as landfills.

Direction from potential conflicting land uses is an important land use consideration. It may not be suitable for a wastewater land application facility to be located upwind from an urban area, or up gradient of a municipal well. See both Sections 6.6 (*Protection of Domestic and Public Well Water Supplies*) and 6.6.3.1 (*Well Location Acceptability Analyses*) for additional information. See also DEQ Policy Memorandum PMOO-6, *Policy for Responding to Odor Complaints*:

http://www.deq.state.id.us/about/policies/pm00_6.cfm

Local officials and the public should be included as part of site selection considerations. Realizing the possible health and nuisance impacts a land-applied wastewater facility can create, public awareness may help determine what may or may not be acceptable. Trying to correct a problem after the fact can be very time consuming and costly.

2.4.2 Nuisance Conditions

Typically, the goal of every WLAP permittee is to avoid nuisance conditions. The most effective way to do this is to prevent them from occurring. The permittee can initiate its own nuisance prevention program for odors, vectors, insects and other nuisance conditions through: (1) equipment design, i.e. designing drainage of all transfer lines to prevent wastewater turning anaerobic; (2) follow through on operation and maintenance that includes management of probable or potential nuisance conditions; (3) proactive company outreach to adjacent property owners and/or immediate community to inform them about the facility and wastewater-land application system. Effective outreach may consist of, offering a tour of the facility, or asking the community for its input to jointly resolve a potential nuisance condition before it becomes a reality. One real life solution to an ongoing nuisance situation by a community occurred after an industry officer was elected to city council and saw their company in the eyes of the whole community.

In addition to what the permittee might choose to voluntarily do, Idaho law provides direction in regard to nuisance conditions. The Idaho State Constitution and Idaho Code recognize four types of nuisance conditions: private, public, general and public health. Prevention and resolution of nuisance conditions by law are based on:

(1) *Local (city/county) laws or ordinances regarding general, public, or public health based nuisances*.
This means that any county law(s) or ordinance(s) pertaining to nuisances that exist may become a condition of the local P&Z permit or building permit issued to a WLAP facility. The local city or county should direct any resolution efforts on city/county laws or ordinances.

(2) *The Idaho State Constitution and Idaho Code*
The constitution and code provides cities and counties with the authority to take necessary steps to protect the public health, safety and general welfare of citizens within their jurisdictions. As such, abatement of general or public nuisances may also be resolved by a local city or county.

Idaho Code distinguishes between public "health" nuisances and general or public nuisances, granting authority to the district health departments to abate public "health" nuisances.

(3) *Compliance With Required Permit Conditions*
Prevention and resolution of nuisance conditions may be a condition of a license or permit. Compliance with required permit conditions is addressed by the agency with permitting authority such as the Department of Water Resources for drilling a well or DEQ for an air quality permit or a WLAP permit. One example of language used to address potential nuisance conditions in a WLAP permit follows:

"Wastewater must not create a public health hazard or nuisance condition as stated in IDAPA Section 16.01,2600,03. In order to prevent public health hazards and nuisance conditions the permittee shall:

a. Apply wastewater as evenly as practicable to the entire treatment area;

b. Prevent organic solids (contained in the wastewater) from accumulating on the ground surface to the point where the solids putrefy or support vectors or insects; and

c. Prevent wastewater from ponding in the fields to the point where the ponded wastewater putrefies or supports vectors or insects."

2.5 References

General Soil Maps for Idaho, 1984

Soil Survey Staff. 1975. Soil Taxonomy. U.S. Dept. Agr. Handboook No. 436. U.S. Govt. Printing Office, Washington.

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4. Constituent and Hydraulic Loading

4.1 Soil, Water, and Hydraulic Loading

Wastewater-Land Application Permit (WLAP) sites are to be managed as agronomic units for the efficient treatment and beneficial reuse of nutrients and water while maintaining soil productivity and protecting beneficial uses of ground water. The following sections discuss soil and water principles as they relate to wastewater land treatment, and hydraulic loading of wastewater land treatment sites. Guidance related to hydraulic loading is discussed in sub-sections on both growing and non-growing season hydraulic loading.

4.1.1 Soil and Water Principles related to Wastewater Land Treatment

The ability of the soil to receive and transmit water is an important element of successful wastewater treatment through land application. The mechanisms and pathways of flow through the soil of applied wastewater and precipitation, in both the unsaturated and saturated phases, determine the initial movement and subsequent location of the waste elements. The objective of a slow rate wastewater land treatment system, whether flood or spray irrigation, is to assimilate and treat all applied wastewater and expected precipitation.

To meet the objectives associated with each treatment site, certain soil water variables must be understood. The principal soil water variable of interest is the hydraulic conductivity. Associated variables are the geological heterogeneity, topography, depth to ground water, direction of ground water flow, and soil water storage capacity. Hydraulic overloading of soil is a common cause of failure of land treatment systems. Overloading may lead to a rapid leaching of waste elements into ground water, reduction in biological activity (microorganisms, plants, etc.), associated with low gaseous exchange (sustained anaerobic conditions) soil erosion and possible contamination of surface waters.

Soil water movement, both percolation and infiltration, is highly dependent upon pore size and distribution (not necessarily porosity) of the soil. Water moves easily through interconnected large pores and slower as the pore size decreases because the resistance to water flow increases. Pore size is related to the structure and the texture of the soil however, texture alone is only an approximate indicator of general pore size. Sandy soils have relatively large pores which allow the rapid transmission of water, where clay soils have small pores with relatively slow water transmission properties.

Soils that have a high degree of swelling, relatively low electrolyte concentration and high sodium adsorption ratio, will result in small pores, even in sandy soils. Conversely, high permeability can be maintained in soils high in clay provided the clay remains in relatively large secondary aggregates through flocculation. The physical action of sprinkler irrigation can cause dispersion of surface soil aggregates and a reduction in the infiltration rate even under good flocculation conditions. Other factors that may decrease pore size in soils are clogging by microbial by-products, suspended solids and/or chemical precipitates such as ferrous sulfide. Microbial by-products and chemical precipitates are most apt to occur under anaerobic conditions. Such conditions are common to poorly managed high-rate systems. Any activity that compacts the soil surface reduces the size of the soil pores and decreases the infiltration rate. Heavy equipment like large rubber tired tractors can compact the surface and should not be used while the area is wet. Grazing of livestock may also cause soil compaction, and should be managed according to guidelines presented in Section 6.

Water application rates should not exceed the soil infiltration rate other than on level areas where runoff will not occur. Otherwise, potential pollution problems might arise. In addition, many crops are sensitive to the poor aeration that is associated with high application rates. Alfalfa, an important part of the wastewater renovation process in many areas, can be damaged by hydraulic overloading. The maximum soil infiltration capacity will have to be determined to help define the land area needed. This must take into consideration the quantity of effluent which is to be treated. This information could be established based on a test run using water similar to the sewage effluent.

In general, the total periodic (weekly) water application can be tied to the evapotranspiration and the soil water-holding capacity. By adding this amount, plus an additional quantity, the crop water requirements can be supplied. The excess water that moves beyond the root zone will likely move to the water table. A more complete picture of water movement in and out of the land treatment area is provided in Figure 4-1.

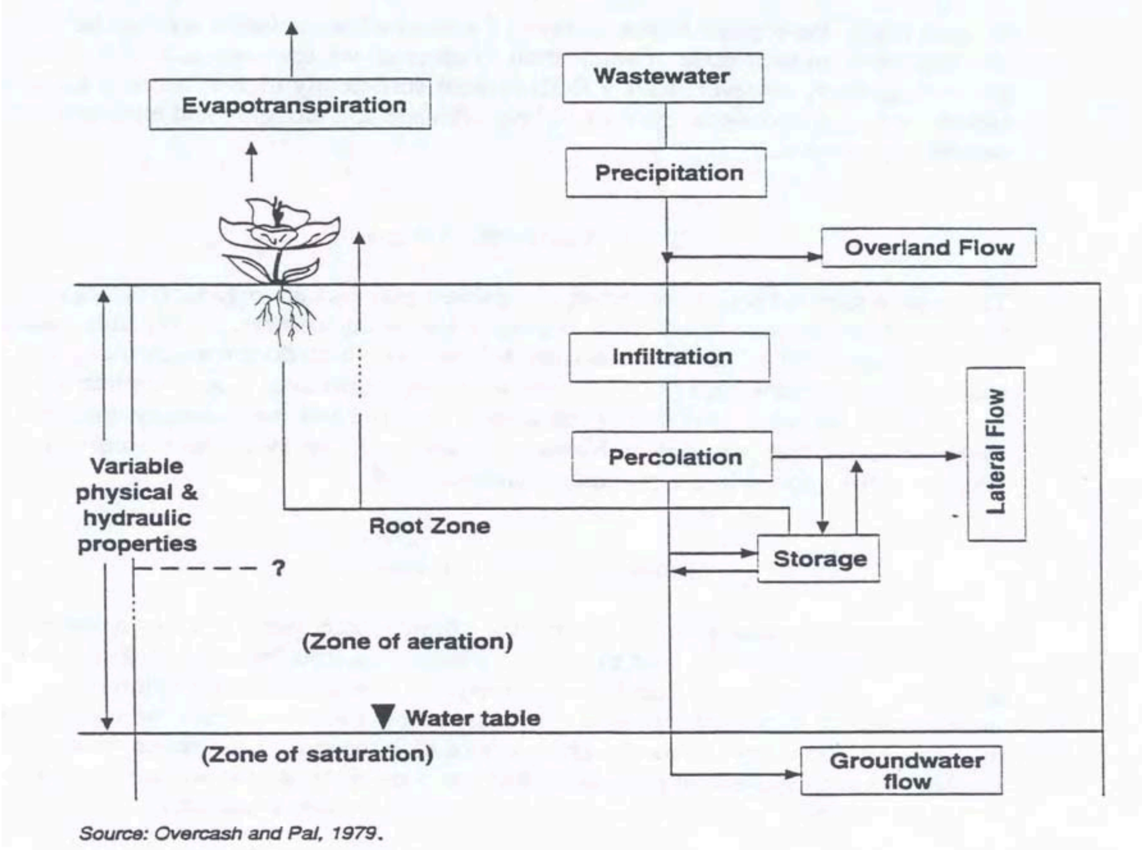

Figure 4-1. Distribution of Wastewater and Precipitation Input to Soil.

Slow-rate land application systems should result in more complete renovation of wastewater than high-rate systems. The exceptions to this observation are with nitrate and a few other substances such as boron. Slow-rate systems can use soils with much higher surface areas (silts and clays) than high-rate systems. The flow rates are therefore slower and a greater proportion of the total flow occurs in smaller pores. This situation will allow for more adsorption of components such as heavy metals and phosphorus.

4.1.2 Growing and Non-growing Season Hydraulic Loading

As previously noted, an important element of successful wastewater treatment through land-application is the ability of the soil to receive and transmit water. However, hydraulic overloading of soil is a common cause of failure of land treatment systems. This is particularly critical in winter months due to freezing conditions and the potential for ice build up. Hydraulic loading seldom poses problems during summer operation since water loss exceeds any gain from precipitation.

If the soil crop system is to be used to treat wastewater, then application rates for the most restrictive operation season will help determine the acceptable loading rates. The element that will determine the average hydraulic loading rate of each system will be based on hydrogeologic and other relevant site conditions discussed in Section 2 and elsewhere.

The following two sections provide guidance on calculating appropriate growing season and non-growing season hydraulic loading rates.

4.1.2.1 Growing Season Wastewater-Land Application

The following is a discussion of growing season wastewater-land application. It includes sections on climatic regions and growing seasons statewide, and growing season hydraulic loading rate determination.

4.1.2.1.1 Statewide Climatic Regions and Growing Seasons

The length of growing season is an important criteria when designing a wastewater-land application system. The growing season is identified by climatic conditions which vary throughout the state. For purposes of this document, the NRCS National Engineering Handbook - *Irrigation Guide*, Title 210, Chapter VI, Part 652.0408(c) and (d), September 1997. Delineates climatic regions with respect to crops and crop growth (Figure 4-2).

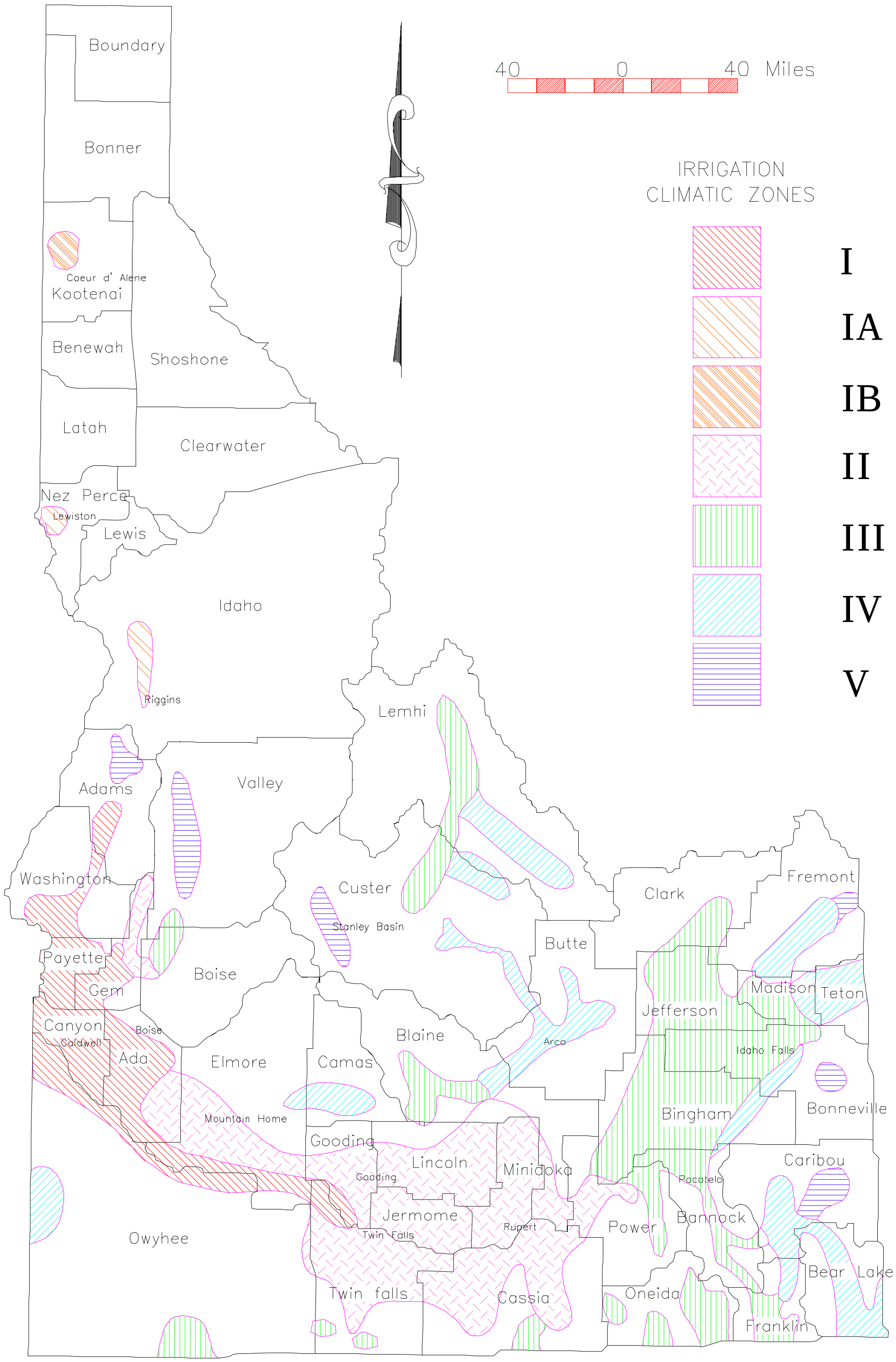

Figure 4-2. Climatic Regions in Idaho from NRCS.

Table 4-1 further describes each of the climatic regions with respect to location and key parameters for crop growth.

Additional information regarding crop growing seasons throughout the state is provided in Section 15. This information comes from the NRCS NEH Part 652.0408(c) and (d). Again, this information is not site specific, but generalized for each region. WLAP proposal designs should substantially reflect these general season lengths, with the understanding that site specific information regarding climatic, site, and management differences may be utilized.

Table 4-1. General Description of Irrigated Climatic Areas.

Irrigation Climate Area	General Location of Irrigated Climatic Areas	Frost Free Range (days)	July *f Factor Range	Representative Station			
				Station Location	Frost-Free Period (days)		July *f Factor
		32˚-32˚			32˚	28˚	
I	Lower Snake River from Weiser to Hagerman, except Mt. Home plateau. Weiser, Payette, Boise River Areas.	140 to 160	7.6 to 8.1	Caldwell	147	169	7.7
IA	Riggins, White Bird, and Lewiston	175 to 185	7.5 to 8.5	Lewiston	187	225	8.0
IB	Rathdrum Prairie Area	135 to 155	6.9 to 8.1	Coeur d' Alene	145	179	7.5
II	Snake River Plains from Mt. Home Plateau to American Falls, Including Bliss, Gooding, Shoshone, Oakley, Raft River. Middle Payette, Squaw Creek Area.	120 to 140	7.14 to 7.65	Rupert	132	158	7.46
III	Malad & Bear River Valley to Alexander, Marsh Creek and Portneuf River, Dubois, Snake river from American Falls to Chester and Heise on the South Fork, Challis to Salmon and Lower Lemhi.	100 to 120	6.84 to 7.51	Sugar City	104	128	6.98
IV	Ashton, Upper Lemhi, Pahsimeroi, Arco, Mackay, Howe, Montpelier, Grace	80 to 100	6.53 to 7.09	Arco	82	122	6.89
V	McCall, New Meadows, Stanley Basin, Greys Lake, Green Timber	50 to 80	6.62 to 6.69	McCall	59	100	6.69

*f = monthly consumptive use factor from the formula for determining water requirements for irrigated areas

The following subsections are intended to assist in the evaluation of wastewater-land application treatment design during the growing season.

4.1.2.1.2 Growing Season Hydraulic Loading Rate

Timely applications of the wastewater are needed to use the site at an optimum level. Schedules of applications will depend on crop water requirements, the strength and volume of wastewater, weather conditions, harvesting periods, and maintenance requirements. As the seasons change, the operator needs to continually evaluate the rates of application, etc., and make necessary changes in management. Good overall management of the site which includes these elements is critical in maintaining the treatment capabilities of the site.

Those systems which have slow rate infiltration and crops should be discontinued at times due to adverse weather, for maintenance purposes, harvest periods, or various other reasons. Rest periods are essential in preventing soil clogging and other adverse effects. Dose-rest cycles must be a part of the method of applying liquid wastes. It is common to use a procedure of one day of application followed by a rest period. However, actual dose-rest periods are site specific and dependent upon the characteristics of the wastewater and crop requirements. Rest periods in some cases can be as much as several weeks or months.

Hydraulic loading rates will differ for each site. Additional irrigation water can be added to meet the demands of plant growth. These guidelines are geared toward sites where wastewater is applied all year long. The wastewater application rates can be increased for seasonal (summer) use but should meet the general concepts of crop utilization and ground water protection.

Both wastewater and supplemental irrigation water should be applied at rates commensurate to the consumptive use requirements of the crop as they vary seasonally. The growing season hydraulic loading rate is the Irrigation Water Requirement (IWR) and can be defined as follows:

$IWR = IR_{net}/E_i$

Where:

IR_{net} = net irrigation requirement; the depth of irrigation water, exclusive of precipitation, stored soil moisture, or ground water, that is required consumptively for crop production and required for other related uses. Such uses may include water required for leaching, frost protection, etc. as the following equation relates:

$IR_{net} = CU - (PPT_e + \text{carryover soil moisture}) + LR$

The monthly IR_{net} (referred to as Mean Net Irrigation Requirement, or Mean IR) may be obtained by crop type for the historic period of record (before 1983) for a particular weather station from the following web site: http://www.kimberly.uidaho.edu/water/appndxet/index.shtml.

It should be noted that data compiled and provided at the web site:

http://www.kimberly.uidaho.edu/water/appndxet/index.shtml is for the historical period of record of each weather station prior to 1983, and would not reflect the historical period of record from 1983 to present.

CU = crop consumptive use. The monthly CU (referred to as Mean Monthly Consumptive Use, or Mean CU) may be obtained by crop type for the historic period of record for a particular weather station from the following web site: http://www.kimberly.uidaho.edu/water/appndxet/index.shtml.

Daily CU for a particular crop and year may be obtained (and summed to generate monthly subtotals) from the USBR web site: http://www.usbr.gov/pn/agrimet/etsummary.html.

Other sources of CU information are discussed in Section 4.1.2.2. below. It is important to note that data referred to is reference evapotranspiration (ET_{ref}) which must be multiplied by an appropriate crop coefficient (Kc) to obtain CU. Kc values are not provided in this guidance.

PPT_e = effective precipitation or effective rainfall; precipitation falling during the growing period of the crop that is available to meet the consumptive water requirements of crops. It does not include such precipitation as is lost to 1) deep percolation below the root zone, 2) surface runoff, or 3) wet canopy and wet soil losses associated with irrigation events.

The monthly PPT_e for a particular weather station for the historic period of record may be derived from data provided at the following web site: http://www.kimberly.uidaho.edu/water/appndxet/index.shtml.

Specifically, $PPT_e = CU – IR_{net}$ (i.e. Mean IR). To back-calculate monthly PPT for a particular weather station for the historic period of record, divide PPT_e by 0.7. Also, Section 15 provides a table and equations for calculating PPT_e (from USDA, 1993).

LR = leaching requirement; the fraction of the irrigation water that must be leached through the crop root zone to control soil salinity at any specified level.

E_i = irrigation efficiency; the percentage of applied irrigation water that is stored in the soil and available for consumptive use by the crop. Ranges for irrigation efficiencies are given in Table 4-2 (from Follett et al. 1991). Additional irrigation efficiency information for typical irrigation systems can be found in Neibling (1998) and at the following US Bureau of Reclamation Web site:

http://www.usbr.gov/pn/agrimet/irrigation.html#Efficiency)

Table 4-2. Irrigation Application Efficiencies

TYPE OF SYSTEM	APPLICATION EFFICIENCY
Surface	%
Furrow gated-pipe without reuse	40-75
Furrow gated-pipe with reuse	70-85
Furrow siphon tube	40-75
Graded border	50-85
Level Basin	70-85
Sprinkler	
Hand move	60-80
Solid-set	60-85
Sideroll-towline	60-80
Boom	55-75
Traveler	55-75
Center pivot	75-90
Corner pivot	70-85
Linear move	75-90
Trickle	
Point source	65-90
Lateral source	60-85

Follett et al., 1991

4.1.2.2 Non-Growing Season Wastewater-Land Application

The following section includes a general discussion of non-growing season wastewater land application, determining non-growing season loading rates, and a discussion of criteria for granting exceptions to non-growing season loading guidance.

4.1.2.2.1 Non-Growing Season Wastewater-Land Application – General Discussion

Some sites may wish to treat wastewater during the non-growing season, necessitating that loading capacity be calculated separately from growing season loading rates. Other sites may hold wastewater during the non-growing months which requires storage pond design criteria be submitted to DEQ for review and approval. Non-growing season loading and storage present economic challenges as land, treatment, and storage costs can be high.

The basic criteria used in designing non-growing season wastewater-land treatment includes but is not limited to COD loading, nutrient loading, hydraulic loading, soil, soil-water storage and climatic conditions.

Excessive non-growing season wastewater-land application may contribute to secondary contamination of the ground water or surface water resource. Excessive COD and/or hydraulic loading coupled with low temperatures that limit microbial oxidation, and uncontrollable spring thaws may cause anaerobic conditions to develop whereby an electron rich chemical environment reduces iron and manganese to mobile forms which can leach.

Generalized non-growing seasons as found in the NRCS NEH, Part 652.0408(d) and in Section 15. WLAP proposal designs should substantially reflect these season lengths, with the understanding there may be climatic, site, and management differences not reflected in and which may modify the generalized information.

Below is presented guidance for non-growing season wastewater-land application site design.

4.1.2.2.2 Non-growing Season Hydraulic Loading Rate (HLR_{ngs})

This section provides guidance on determining non-growing season hydraulic loading rates (HLR_{ngs}), which in theory allows for no leaching. The method provided below yields rates which, in general, are environmentally protective. However, the appropriateness of the guideline value obtained must be evaluated on a case-by-case basis. The HLR_{ngs} is defined as follows:

$$HLR_{ngs} = [AWC + E - PPT_{ngs}] + LR$$

Where:

AWC = available water holding capacity of the soil to 60 inches or root limiting layer, whichever is shallowest. Note these are general and readily obtainable numbers based on physical soil properties which presumably do not change, rather than on crop rooting depth, which changes as the crop changes. Soil AWC information may be found in National Resource Conservation Service (NRCS) Soil Survey Reports. Spatial and aspatial data (including soil AWC) may be down-loaded from the following NRCS web site: http://www.ftw.nrcs.usda.gov/ssurgo_ftp3.html.

Note that variability of soils on a hydraulic management unit generally means variable AWCs as well. In some cases, an acreage weighted average AWC may be an appropriate estimate for the unit. In other cases, selecting an AWC from the most limiting soil of reasonable a real extent may be the more environmentally protective. Such determinations need to be done on a case-by-case basis.

PPT_{ngs} = average precipitation falling during the non-growing season. Non-growing seasons are listed by crop in Section 15.8 below**.** Crop consumptive use information found in Section 15.8 should not be used. Mean monthly precipitation (thirty year averages) for weather stations in Idaho are found in Section 15.9 below. The period of record for data in Section 15.9 is dated (1961-1990). More recent average precipitation data (1991 to 2002) may be found in AgriMet summary spreadsheet tables found in DEQ Intranet site G:\Wastewater Common-Drive\TGR Project\Project Area|Section 1.1\AgriMet summary SSs|. Also, average precipitation data from1948 to present may be found at the Desert Research Institute – Western Regional Climate Center web site: http://www.wrcc.dri.edu/summary/climsmid.html.

PPT_e should not be used when calculating NGS hydraulic balances. Non-growing season ET losses are reckoned to account for non-leaching and non-runoff PPT losses.

E = estimate of evaporation/evapotranspiration during the non-growing season. This guidance recommends three sources for E estimates:

1) Lysimeter measurement of non-growing season ET for the Kimberly area is found in Wright (1991~~3~~). For WLAP facilities near Kimberley ID, results of Wright (1991) can be utilized.

2) Non-Averaged NGS ET Data: Non-growing season ET data (for bare wet soil) for different weather stations may be found at the AgriMet Historical Archive Weather Data Access Web Site: *http://www.usbr.gov/pn/agrimet/webarcread.html*. These values are calculated using the 1982 Kimberly-Penman Equation as modified in Wright (1996) (Dr. James Wright, Personal Communication; August 20, 2003). Daily ET data for time periods between 1991 and present may be down-loaded. In order to obtain historical monthly averages of non-growing season ET, down-loaded data from the period of record must be manipulated in a spreadsheet so that data may be summed and averaged by month. Data from a single year of record should not be utilized to determine non-growing season ET. After monthly average values of ET are calculated, they should be multiplied by an ‘evaporation coefficient’ of 0.7 to account for snow cover and dry soil surface conditions (J. Wright, August 20, 2003).

3) Averaged ET Data: Averaged summary non-growing season ET data (1991 to 2002) may be found in AgriMet summary spreadsheet tables found in DEQ Intranet site G:\Wastewater Common-Drive\TGR Project\Project Area|Section 1.1\AgriMet summary SSs|. These average data must also be multiplied by an ‘evaporation coefficient’ of 0.7 as discussed above.

LR = Leaching requirement: See definition in Section 4.1.1.2.1 above. It is generally observed that soil EC levels from wastewater land application sites do not show increases over time, which increases would indicate salt build-up. Soil EC levels usually reflect agronomically acceptable ranges (i.e. which would not cause crop yield decrements). Apparently there is sufficient leaching taking place both through normal agronomic practices employed at wastewater land application sites, and at sites practicing non-growing season application. DEQ allows the inclusion of a leaching requirement if soil EC data indicate salt build-up.

In addition, non-growing season hydraulic loading should conform to the following guidelines:

1. Wastewater should not be applied on frozen soils where frozen soil is defined as 0° centigrade or less in the upper six inches of soil.
2. Wastewater should not be applied when it will freeze and accumulate on the surface of the soil. This is to avoid spring thaw conditions which could overload the soils both hydraulically and with respect to COD. This is also intended to avoid potential for runoff which will not ensure adequate treatment for COD and could result in phosphorus contamination of surface water.
3. Wastewater should be applied evenly over the non-growing season site. The site should be sprinkler irrigated with winterized equipment; flood or furrow generally results in prolonged saturated conditions causing both the development of reducing conditions and leaching in the spring.

4.1.2.2.3 Criteria For Granting Exceptions To Non-Growing Season Loading

An applicant or permittee may wish to design a system with non-growing season loading rates that exceed the basic criteria and guidance given above. Any request for an exception to the basic criteria must still achieve programmatic objectives of protecting public health and preserving the beneficial uses of surface and ground water. Such requests must demonstrate that non-growing season wastewater-land application:

- will not cause projected impacts to ground water or prolonged anaerobic conditions to develop in the soil or aquifer, such that the flux of redox sensitive constituents and soluble organics beyond the crop root zone does not cause an exceedance of the primary or secondary water quality standards;

- will be conservative enough to handle a variety of demanding case scenarios including late winter/early spring thaw or precipitation events without runoff, hydraulic overloading, or other crisis conditions;

- will not create or contribute to nuisance conditions or adversely affect public health;

- will be conducted utilizing either best practical methods, approved best management practices, or best available technology, whichever most effectively minimizes impacts to ground water and surface water.

4.1.3 References

Follett, R.F., Keeney, D.R., and Crose, R.M., 1991. Managing Nitrogen for Ground Water Quality and Farm Profitability.

Neibling, Howard. August 1998. Introduction to Irrigation System Planning and Management. Biological and Agricultural Engineering Department. University of Idaho.

USDA - National Resource Conservation Service. National Engineering Handbook - Irrigation Guide, Title 210, Chapter VI, Part 652, September 1997.

USDA National Resource Conservation Service. National Engineering Handbook - Irrigation Water Requirements, Title 210, Chapter VI, Part 653.0207e. September 1997.

Wright, J.L. 1996. Derivation of Alfalfa and Grass Reference Evapotranspiration. In. Evapotranspiration and Irrigation Scheduling, C.R. Camp, E.J. Sadler, and R.E. Yoder (ed.). Proc. Int. Conf., ASAE, San Antonio, TX. pp. 133-140.

Wright, J.L. 1991. Using weighing lysimeters to develop evapotranspiration crop coefficients. Lysimeters for evapotranspiration and environmental measurements. Proc., 1991 International Symposium on Lysimetry, ASCE, New York, NY, 191-199.

4.2 Nitrogen

Nitrogen is an important constituent of wastewater and may be one of the main limiting factors in designing a system for wastewater treatment by land application. Therefore, the assimilative capacity for nitrogen is an important part of the design of a land treatment system. Nitrogen removal can be very efficient in the soil crop system.

Nitrogen is lost or removed from soil systems through several mechanisms including ammonia volatilization, denitrification, crop uptake and harvest, and leaching. One of these mechanisms, denitrification, requires anaerobic conditions, yet the soil plant system requires an aerobic environment. Aerobic conditions in the root zone and occasional anaerobic conditions below the root zone promote denitrification.

On a land application site, efforts must be made to control the leaching and runoff losses of nitrogen compounds. Conditions of rapid water movement beyond the root zone, which can occur with excess water application to soils, can lead to increased nitrate levels in ground water. The basic approach to reduce leaching is to have a crop that will retain or use the nitrogen. This will help prevent excess nitrate accumulation and potential leaching problems and subsequent ground water pollution. The basic approach in controlling runoff is to implement best management practices at each site.

4.2.1 Nitrogen Chemistry

Nitrogen in the wastewater effluent can be found in both inorganic and organic forms. Inorganic forms include ammonium (NH_4^+), ammonia (NH_3), nitrite (NO_2^-), and nitrate (NO_3^-). Ammonium ion (NH_4^+) tends to remain in the soil and can be held in the soil on clay and organic matter cation exchange sites. It can be utilized by both plants and microorganisms as a nitrogen source. Nitrogen in the NH_3 form may be lost from the system as a gas through volatilization. NO_2^- is a highly mobile anion and is an intermediate during the microbial conversion of ammonium to nitrate. It can be toxic to higher plants. NO_3^- is readily used by both plants and microorganisms. This highly mobile anion is of primary interest because of its potential impacts on ground water quality.

Organic nitrogen is bound in carbon containing compounds. Examples of organic forms are nucleic acids, proteins (enzymes) and amino acids. Organic nitrogen is generally not available for direct plant uptake. An aerobic environment allows the transformation of organic nitrogen to NH_4^+ and NO_3^-.

Nitrogen in wastewater may undergo oxidation-reduction reactions when they are added to the soil. These reactions are especially important in the case of nitrogen since it is potentially a serious pollutant in wastewater and its behavior in the soil is highly dependent on its state of oxidation. Organic nitrogen is mineralized to form NH_4^+ or NH_3. In aerated soil, NH_4^+/NH_3 is nitrified and converted to NO_3^- and will move with the wetting front. Under anaerobic soil conditions NO_3^- will be reduced to atmospheric nitrogen (N_2) and gaseous oxides nitrogen (NO_x). N_2 and NO_x tend to be lost from the system as gases (Figure 4-3).

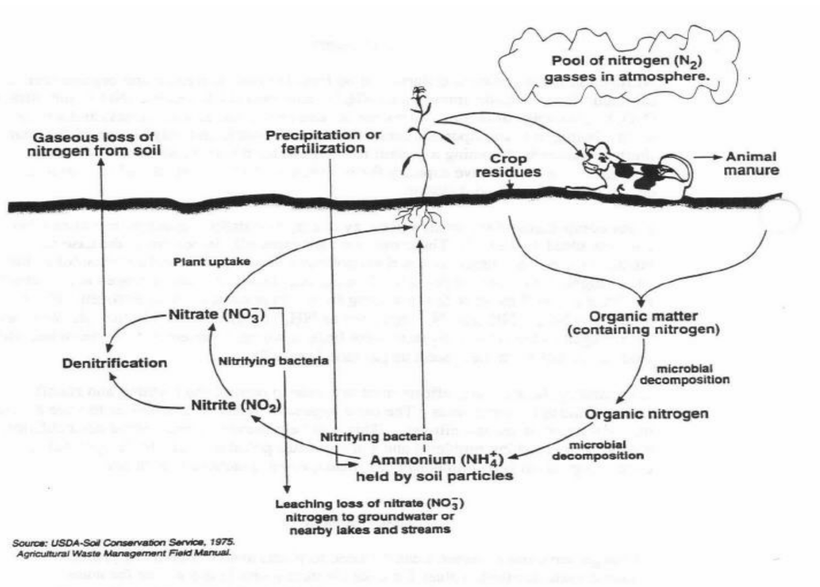

Figure 4-3. General Nitrogen Cycle.

4.2.2 Nitrogen Loading

The nitrogen loading rates depend upon a number of factors. The main factor is the requirement that the nitrate nitrogen levels of ground water outside the property boundaries of the application system do not exceed the water quality standard of 10 mg/L. (See Section 7). Ground Water Monitoring for more information). The previous section describes the different forms of nitrogen and how they can become nitrate. It is therefore important to know the levels of organic nitrogen, ammonium (NH_4), and nitrite (NO_2^{-1}) in addition to nitrate. The land application system must be operated in a manner that removes nitrogen based on the forms of nitrogen which are known to occur.

To help ensure the protection of ground water, keeping in mind that the wastewater application site is for treatment purposes, a nitrogen application rate should be established. These guidelines recommend that nitrogen loading rates be based on crop utilization plus 50 percent. The excess is provided for normal losses of applied nitrogen over the needs of the crop. Additional irrigation water should be adequate to allow for maximum plant growth and eventual harvest. Crop testing for nitrate as N should be conducted to prevent nitrate poisoning. Tables in Section 7 give examples of nitrogen demands and typical crop uptake for selected crops.

4.2.2.1 Non-Growing Season Nutrient Loading Rate (NLR_{ngs})

Nutrient loading of wastewater-land application sites should be commensurate with crop needs, uptake, and efficiency of crop uptake. Non-growing season applications should be made so that applied nutrients are stored in the soils to be available during the growing season. Justification for nutrient loading should demonstrate leaching of nutrients in rates and amounts which substantially protect beneficial uses of ground water. As with growing season loading rates, potential or actual effects on ground water should be below water quality standards.

One example to calculate non-growing season Nitrogen Loading Rate (NLR_{ngs}) follows:

$NLR_{ngs} = (N_{crop} * 1.5) - N_{gs}$

Where:

N_{crop} = *crop nitrogen requirement*

N_{gs} = *nutrient load applied during the growing season*

4.2.2.2 Growing Season Nutrient Loading Rate (NLR_{gs})

As stated above, general rates for nitrogen loading are 150% of crop uptake. This approach does not take into consideration nitrogen resident in the soil profile, or nitrogen needs as a function of yield goal. Other major nutrient needs such as phosphorus and potassium are addressed in the University of Idaho crop nutrient guides (see also Section 4.9 below for further discussion of phosphorus). The University of Idaho crop nutrient guides or demonstrated agronomic utilization may also be utilized to help determine appropriate nutrient loading rates. Whichever approach is chosen should maintain ground water quality so that appropriate water quality standards are not exceeded. Spring soil testing is generally needed to determine resident nutrients (nitrogen in particular) at the beginning of the season, in order to calculate how much the management unit should be loaded.

4.2.2.3 Determining Nitrogen Loading Limit Compliance

Standard WLAP permit templates for municipal sites include limits on the amount of nitrogen that can be applied to the land application site.

The WLAP permit limits are as follows:

Parameter	Permit Limit
Total Nitrogen	150 of typical crop uptake; 150% of uptake values from standard tables; or Use of University of Idaho Fertility Guides.

In order to determine compliance with 150% of typical crop uptake, take the following steps:

1. Calculate the nitrogen uptake by the crop or crops harvested from each hydraulic management unit on the site for the three most recent years of data plant tissue data. Select the median value from these data and multiply by 1.5. This is the loading limit. (in pounds per acre)

   To determine the permit limit for nitrogen using standard tables, find the crop type in Section 7 and look up the nitrogen content. Then multiply by crop yield (per acre) and by 1.5. This is the loading limit based on a standard table. If the crop grown at the site is not included in Section 7, contact DEQ to get nutrient uptake for the crop being grown.

   Note that the permit limit may change from year to year if the crop type changes or the crop yield changes.

2. Calculate the amount of nutrients applied by wastewater application or from other sources, such as supplemental fertilizers. (in pounds per acre). To make this calculation, the following information is required:
   a. Volume of wastewater applied, gallons/year
   b. Wastewater quality in mg/l. Use total nitrogen (sum of Total Kjeldahl Nitrogen and Nitrite+Nitrate Nitrogen)
   c. The amount of supplemental fertilizer applied or any other nutrient sources (pounds per acre)
   d. Calculate wastewater N loading from wastewater volume, concentration, and site acreage, and then sum fertilizer loading rate to obtain total N loading.
3. Compare the permit limit calculated in Step 1 above to the amount of nitrogen applied calculated in Step 2 to determine compliance.

   Example calculations are provided below.

4.2.2.4 Example Calculations

Example 1

Crop type: Alfalfa Hay
Crop yield: 4.5 tons/acre
Wastewater applied to land application field: 6 million gallons
Land application area: 20 acres
Wastewater total nitrogen: 20 mg/l (ppm)
No supplemental fertilizer applied

1a. Calculate crop uptake of nitrogen
For alfalfa hay, the nitrogen uptake (from Table 7-26 Section 7) is 50.4 pounds per ton of yield.
Nitrogen uptake: 4.5 tons/acre x 50.4 pounds N/ton = 226.8 pounds/acre

1b. Calculate the nitrogen permit limits (150% of crop uptake)
Nitrogen application permit limit: 226.8 x 1.5 = 340 pounds/acre
(round off to nearest whole number)

2. Calculate the amount of nitrogen applied with the wastewater
Nitrogen: $\frac{6\ \text{MG}}{\text{year}} \times 20\ \text{mg/L N} \times \frac{8.34\ \text{pounds/MG}}{1\ \text{mg/L}} \times \frac{1}{20\ \text{acres}} = \frac{50.0\ \text{lbs Nitrogen}}{\text{acre}}$

3. Compare nitrogen applied versus the permit limit to determine compliance.

	Permit Limit 150% of crop uptake	Amount applied	In compliance with permit limit?
Nitrogen	340 pounds/acre	50 pounds/acre	Yes

Example 2

Crop type: Forest Site (pine tree)
Crop yield: Harvest per silvicultural plan
Wastewater applied to land application field: 14 million gallons
Land application area: 26 acres
Wastewater total nitrogen: 15 mg/l (ppm)
No supplemental fertilizer applied

1a. Calculate crop uptake of nitrogen
From Table 7-26, Section 7, for tree sites, the nitrogen uptake allowance is up to 220 pounds per acre.

1b. Calculate the nitrogen permit limit~~s~~ (150% of crop uptake)
Nitrogen application permit limit: 220 x 1.5 = 330 pounds/acre
(round off to nearest whole number)

2. Calculate the amount of nitrogen applied with the wastewater
Nitrogen: $14\ \frac{\text{MG}}{\text{year}} \times 15\ \text{mg/L N} \times \frac{8.34\ \text{pounds/MG}}{1\ \text{mg/L}} \times \frac{1}{26\ \text{acres}} = 67.4\ \frac{\text{lbs Nitrogen}}{\text{acre}}$

3. Compare nitrogen applied versus the permit limit to determine compliance

	Permit Limit 150% of crop uptake	Amount applied	In compliance with permit limit?
Nitrogen	330 pounds/acre	67.4 pounds/acre	Yes

4.3 Chemical Oxygen Demand (COD) and Total Suspended Solids (TSS)

This section discusses both chemical oxygen demand (COD) and total suspended solids (TSS) as they relate to wastewater land treatment. These two constituents are related and, in certain respects, are descriptive of similar chemical characteristics and influence on the crop-soil system, as will be discussed below.

4.3.1 Chemical Oxygen Demand (COD)

The following section discusses COD assimilative capacity in the soil system, soil chemistry and oxygen demand, and both growing and non-growing season COD loading guidelines for wastewater land treatment sites.

4.3.1.1 Soil COD Assimilative Capacity

Soil has long been identified as a good medium for the assimilation of the organic matter in wastes. A common measure of organic matter is chemical oxygen demand (COD). This is a particularly useful measurement when considering factors influencing the soil chemical environment. The degree of oxygen demand imposed upon the soil system is an important factor in determining to what degree the soil is aerobic or anaerobic, and what chemical processes would be taking place in the system.

The upper limit on the amount of COD that a soil can assimilate depends largely on the environmental conditions and the nature of the waste applied. The major elements which affect the decomposion of organic matter applied to the soil are: 1) carbon:nitrogen ratio; 2) oxygen supply; 3) temperature; 4) soil moisture content; 5) pH; and 6) salinity. Soil should not be saturated for extended periods in order to keep oxygen levels up. Certain moisture levels are needed for optimum bacterial decomposition. The rate of decomposition increases with increasing temperature, with about 38ºF being very slow and maximum rates occurring around 80ºF. Bacteria, which are the most effective waste decomposers, function best in soils with a pH range of 6.5-8.5 which are neutral to slightly alkaline. High levels of salinity can reduce COD removal by organisms in the soil.

Of the many benefits resulting from the application of organic matter to the soil, one is the binding of soil particles together into aggregates (aggregation). Microbial decomposition end products include compounds which promote aggregation. This helps produce more pore space in the soil and may result in improved aeration and increased infiltration capacity.

Soil clogging associated with high COD loadings, can severely limit the function of a site to treat wastewater. The conditions that could cause such a problem should be evaluated in order to understand the capacity of soil for wastewater treatment. Clogging can result from biochemical reactions, excessive loading of organic and inorganic materials (both dissolved and particulate), excessive hydraulic loading, and the physical properties of the soil surface and profile.

Clogging generally occurs in the top few inches of soil. This can be seen as a function of the organic mat that is largely independent of the coarseness of the soil. The continued existence of anaerobic conditions in the soil surface layer can lead to clogging. Anaerobic conditions result in a low rate of biological activity. This can result in sludge accumulation and production of ferrous sulfide.

In most cases, the organic matter content of municipal wastewaters will not be the limiting factor in their rates of application. Industrial wastewaters such as from food processing, may, however, have a COD content sufficiently high to become a limiting factor. With the application of high strength wastewaters, oxygen may be quickly depleted. If the soil pores have been clogged by wastes or are waterlogged, the diffusion of air is restricted, the rate of decomposition is lowered and the chemical end products will differ. Some of these by-products cause nuisance odors. Odors can be controlled however by maintaining conditions favorable to aerobic (oxygen present) waste decomposition. Under anoxic (oxygen absent) conditions, some elements within the soil, such as iron and manganese, can be reduced to soluble and mobile forms.

In order to help maintain aerobic conditions within the soil and to prevent associated problems, the yearly average organic loading rate should not exceed 50 pounds COD per acre per day. These guidelines are based on the application of wastewater all year long. This application rate is most commonly tied to the related nitrogen concentrations. The wastewater application rates can be increased for seasonal (summer) use but should be at or below soil assimilation rates, and at rates to insure ground water protection. Adequate dose-rest cycles will help alleviate soil clogging and eliminate oxygen depletion problems.

4.3.1.2 Non-Growing Season COD Loading Rate

The COD loading of wastewater-land application sites during the non-growing season , according to the *Guidelines*, is to be less than 50 lbs/acre/day based on a non-growing season average. There may be cause to reduce this rate if the site is flood irrigated.

Justification for proposed COD loading during the non-growing season should be made for loadings near guideline rates. Such justification may reference empirical data (what has worked, or what has not), and/or may involve more theoretical approaches which take into consideration oxygen diffusion rates into soil, re-aeration times, soil porosity, temperature, and irrigation scheduling (Carlisle and Phillips, 1976).

4.3.1.3 Growing Season COD Loading Rate

COD loading during the growing season, compared to non-growing season loading, is generally a less constraining design parameter. Nevertheless, justification for loadings in excess of the guideline rate of 50 lb/acre/day (based on a growing season average) should be provided as described in the Non-Growing Season COD Loading Rate section.

4.3.2 Total Suspended Solids (TSS)

The total suspended solids content of wastewater may include organic or inorganic particulate matter, with most of the organic solids being volatile. Many of the concerns related to the chemical oxygen demand of the wastewater and related problems with loading rates apply to total suspended solids. Loading rates for total suspended solids need to be carefully evaluated. Acceptable loading for total suspended solids can be defined as that rate which does not significantly reduce the infiltration capacity of the soil or damage the cover crop. Application rates should allow for decomposition of the organic material and the necessary dose-rest cycles to assure that potential problems are minimized.

Although organic solids can be almost completely removed by land application, problems with odors, ponding, insects and damage to cover crops can develop. Excess solids loadings could result in a solids build-up on top of the soil causing reduced infiltration rates. To prevent soil clogging, it is necessary to apply wastewater intermittently, allowing drying or resting periods between applications to permit the infiltration rate, which decreases during application, to recover during the drying cycle. The higher the total suspended solids content of the wastewater, the faster the soil will clog and the more frequent it should dry.

The method of wastewater application will, to some extent, determine the amount of solids that can be applied to a field. Generally, spray irrigation is better suited for the application of more solids per acre than flood irrigation, due to the even distribution of solids. However, the nature of the solids and method of distribution will highly influence the rate of application.

4.4 Trace Elements

Trace elements may be of importance in wastewater land treatment systems. Trace element removal in the soil system is a complex process involving the mechanisms of adsorption, ion exchange, precipitation, and complexation. Adsorption of most trace elements occurs on the surfaces of clay minerals, organic matter, and metal oxides. Cationic Species are generally adsorbed, whereas anions tend to be repelled from these same surfaces. This makes for differences in the rate at which applied anions and cations move through the soil.

Cations that are fixed in exchangeable forms generally remain in place until replaced by another cation. The ability of a soil to retain various cations in exchangeable form depends on several factors, with degree of hydration and valence or charge of the cation being among the most important. On the other hand, anions tend to move with water and generally accumulate near the head of any wetting front of water moving through the soil.

The magnitude of the exchange reactions depends upon the cation exchange capacity (CEC) of the soil which is a function of the type and quantity of clay and organic matter. In general, soils with more clay and organic matter have higher CEC's, and have a larger adsorption capacity for trace elements than sandy soils. Such soils have a resulting higher cation retention capacity. Soils with clayey textures may have infiltration problems and associated drainage and crop growth problems. Soils with substantial content of shrink-swell clays can pose problems for engineered structures as well as have agronomic problems.

Although some trace elements can be toxic to plants and consumers of plants, no accepted toxic threshold values for additions to soil have been established. Ceiling concentrations, annual loading levels, and maximum loadings over the life of a land treatment system for several trace elements (see Tables 1 through 3) have been prescribed in 40 CFR 503.13 Subpart B: Land Application for land applied sewage sludge. In addition, toxicity problems can be reduced by maintaining the soil pH above 6.5.

Removal of trace elements from wastewater normally occurs through sludge generation during initial treatment. For example, effluent from domestic sewage contains very small concentrations of the most toxic metals such as cadmium. The remaining trace elements are nearly all removed in soils suitable (high CEC) for slow rate systems. Therefore in many land treatment systems, trace element removal will not be a limiting factor.

Title 40: Protection of Environment
PART 503—STANDARDS FOR THE USE OR DISPOSAL OF SEWAGE SLUDGE
Subpart B—Land Application

§ 503.13 Pollutant limits.
(a) Sewage sludge. (1) Bulk sewage sludge or sewage sludge sold or given away in a bag or other container shall not be applied to the land if the concentration of any pollutant in the sewage sludge exceeds the ceiling concentration for the pollutant in Table 1 of §503.13.
(2) If bulk sewage sludge is applied to agricultural land, forest, a public contact site, or a reclamation site, either:
(i) The cumulative loading rate for each pollutant shall not exceed the cumulative pollutant loading rate for the pollutant in Table 2 of §503.13; or
(ii) The concentration of each pollutant in the sewage sludge shall not exceed the concentration for the pollutant in Table 3 of §503.13.
(3) If bulk sewage sludge is applied to a lawn or a home garden, the concentration of each pollutant in the sewage sludge shall not exceed the concentration for the pollutant in Table 3 of §503.13.
(4) If sewage sludge is sold or given away in a bag or other container for application to the land, either:
(i) The concentration of each pollutant in the sewage sludge shall not exceed the concentration for the pollutant in Table 3 of §503.13; or
(ii) The product of the concentration of each pollutant in the sewage sludge and the annual whole sludge application rate for the sewage sludge shall not cause the annual pollutant loading rate for the pollutant in Table 4 of §503.13 to be exceeded. The procedure used to determine the annual whole sludge application rate is presented in appendix A of this part.
(b) Pollutant concentrations and loading rates—sewage sludge.—

Table 4-3. Ceiling Concentration, Cumulative Pollutant Loading Rates, Pollutant Concentrations, Annual Pollutant Loading Rates for 40 CFR 503.13.

(Table 1 of § 503.13_Ceiling Concentrations)

Pollutant	Ceiling concentration (milligrams per kilogram) \1\
Arsenic	75
Cadmium	85
Copper	4300
Lead	840
Mercury	57
Molybdenum	75
Nickel	420

Selenium	100
Zinc	7500

\1\ Dry weight basis.

(2) Cumulative pollutant loading rates.

Table 2 of § 503.13_Cumulative Pollutant Loading Rates

Pollutant	Cumulative pollutant loading rate (kilograms per hectare)
Arsenic	41
Cadmium	39
Copper	1500
Lead	300
Mercury	17
Nickel	420
Selenium	100
Zinc	2800

(3) Pollutant concentrations.

Table 3 of § 503.13_Pollutant Concentrations

Pollutant	Monthly average concentration (milligrams per kilogram) \1\
Arsenic	41
Cadmium	39
Copper	1500
Lead	300
Mercury	17
Nickel	420
Selenium	100
Zinc	2800

\1\ Dry weight basis.

(4) Annual pollutant loading rates.

Table 4 of § 503.13_Annual Pollutant Loading Rates

Pollutant	Annual pollutant loading rate (kilograms per hectare per 365 day period)
Arsenic	2.0
Cadmium	1.9
Copper	75
Lead	15
Mercury	0.85
Nickel	21
Selenium	5.0
Zinc	140

$$AAR = \frac{N}{0.0026} \qquad Eq.\ (1)$$

(c) Domestic septage. The annual application rate for domestic septage applied to agricultural land, forest, or a reclamation site shall not exceed the annual application rate calculated using equation (1).

Where:

AAR=Annual application rate in gallons per acre per 365 day period. N = Amount of nitrogen in pounds per acre per 365 day period needed by the crop or vegetation grown on the land.

[58 FR 9387, Feb. 19, 1993, as amended at 58 FR 9099, Feb. 25, 1994; 60 FR 54769, Oct. 25, 1995]

4.5 Salinity and Sodium Influences

There are a number of potential problems associated with soluble salts and sodium in wastewater when applied to the soil. This section discusses both salinity and sodium influences from wastewater land application to wastewater land treatment sites.

4.5.1 Salinity

High levels of salt in the soil solution may reduce the yield of vegetation or crops grown on the site and adversely impact soil structure which can significantly reduce soil permeability. In most cases salinity will not be a limiting factor. However, consideration~~s~~ should be given to the influence of salt loading to wastewater land treatment sites.

Salinity effects on plants are categorized as: 1) ionic interference; 2) changes in osmotic or diffusional relationships; and 3) toxicity of chemical species. Wastewater high in salts when applied to land can raise the osmotic pressure of the soil solution. The result is that the level in osmotic potential between the soil solution and root cells is reduced such that there is less water uptake by plants. The visible effects of excess salinity are reductions in both total plant size and the rate growth. Salt-affected plants do not respond to the application of fertilizers because they further increase the osmotic potential of the soil solution and compound the salinity effects.

The salinity of wastewater can be estimated from its electrical conductivity. Electrical conductivity is in turn related to total dissolved solids by the following general equation: TDS = 0.64 * EC. Each wastewater will have a unique TDS/EC relationship depending upon content of soluble organic or other non-charged species, and type and activity of soluble salts among other factors. It is advisable to irrigate with wastewater, or wastewater/irrigation water mix, which has an electrical conductivity which would not cause foliar burn, plant toxicity, yield decrement etc. USDA Agriculture Handbook No. 60 (February 1954) Figure 25 and associated text discusses salinity classifications of irrigation waters and their respective hazards, based upon EC levels. Also shown in Figure 25 are classifications of sodium hazards of irrigation waters, based upon SAR levels (see further discussion below). This reference should be consulted when evaluating loading onto wastewater land treatment sites. See the following Web site for further information: http://www.ussl.ars.usda.gov/hb60/offset/Hb60ch5.pdf. See also Tanji (1990) for a more recent text.

4.5.2 Sodium Influences

For a wastewater land application site, the concentrations of sodium (Na), magnesium (Mg) and calcium (Ca) are interrelated and can be controlling factors in the treatment method. The importance of Na, Ca, and Mg is due to their impact on soil structure, which is the major determination for water movement and wastewater treatment. Soils with high levels of exchangeable sodium are called sodic soils, and are defined as soils with sodium adsorption ratio (SAR) values >15 (Bohn, et al. 1979). See further discussion of SAR below. For most crops grown on land treatment sites, Soil SAR values of less than 10 are acceptable. It has been shown that occasional problems may be encountered where SAR values are over 10. High Na in wastewater will displace Ca and Mg from the soil exchange sites, leaving high Na concentrations in the soil. Excessive sodium in soils can promote deflocculation of the soil colloids and swelling of the clay fraction of the soil. Soil structure collapses and water movement becomes severely restricted. A lowering of hydraulic conductivity reduces the water intake and transmission capacity at a site. Such reductions in soil permeability should be avoided.

The degree to which sodium influences soils, and thus the degree to which SAR indicates infiltration problems, is soil-specific. For example, coarse-textured soils like sands are generally less affected by exchangeable sodium than are fine-textured soils such as clays. Soils containing clay of the expanding type, such as montmorillonite, swell and disperse at an increasing rate with increased soil sodium levels.

Since Na, can cause soil structure problems, the levels of Na, Ca and Mg should be determined in the soil profile. An index of sodium influence of both waters, wastewaters, and soils is the sodium adsorption ratio (SAR). The equation for SAR is as follows:

$$SAR = \frac{Na}{(Ca + Mg)/2 \wedge 0.5}$$

where Na, Ca and Mg are measured in milli-equivalents per liter in a soil solution extract or water sample (See Section 7 for further information). Exchangeable sodium percentage (ESP) is another measure of the Na content on soil exchange sites in the soil system relative to the other cations.

4.5.3 References

Bohn, H. L., B. L. McNeal, and G. A. O'Connor. 1979. Soil Chemistry. John Wiley and Sons. 329 pages.

Tanji, K. K. (ed.). 1990. "Agricultural Salinity Assessment and Management", In: ASCE Manuals & Report on Engineering Practice No. 71, 1990. 762 Pages. American Society of Civil Engineers.

United States Department of Agriculture. Agricultural Handbook No. 60. Saline and Alkalai Soils - Diagnosis and Improvement. February 1954.

4.6 Hazardous Wastes

Land application of wastewaters containing hazardous wastes will not be allowed unless the type, concentration and amount can be identified and determined that it is not regulated as hazardous waste, and will not adversely affect the beneficial uses of waters of the State or public health. . In situations where the nature of the wastewater is such that it is not regulated by the regulations discussed below, an evaluation of the suitability for treatment by land application will be made by the Department of Environmental Quality (DEQ) on a case-by-case basis. The key element that determines the feasibility of land application as a wastewater treatment alternative is the ability of the soil crop system to treat, not just dispose, of the wastewater in question.

Land application systems are subject to the Idaho Hazardous Waste Management Act (HWMA) of 1983 and the Rules and Standards for Hazardous Waste IDAPA 58.01.05. The primary purpose~~s~~ of the Federal Resource Conservation and Recovery Act (RCRA) is to provide "cradle to grave" management of hazardous wastes, solid wastes, and regulation of underground storage tanks. Hazardous wastes are subject to regulation in their generation, transport, treatment, storage and disposal under RCRA, Subtitle C. In Idaho, DEQ has primacy to administer the hazardous waste (RCRA) program under the HMWA. Please direct any inquiries regarding testing requirements to determine if a waste is hazardous or any other aspect of managing hazardous wastes to RCRA/HWMA DEQ personnel. Other information pertaining to hazardous waste is included in Section 12 *Information Packet for the Management of Pumpable Wastes*.

Underground storage tanks are regulated according to their contents. RCRA, Subtitle C regulates those underground storage tanks that contain hazardous wastes. The 1984 Amendments to RCRA added Subtitle I, which regulates underground storage tanks containing chemical and petroleum products. Contact DEQ with questions regarding underground storage tanks containing hazardous wastes or questions regarding the requirements for underground storage tanks containing chemical or petroleum products.

The Rules Regulating the Disposal of Radioactive Materials not Regulated under the Atomic Energy Act of 1954, as Amended IDAPA 58.01.10 govern disposal of wastes containing radioactive substances

4.7 Biological Characteristics

The removal of microorganisms, particularly human pathogens, from wastewater is an important consideration in land treatment. Microorganisms include bacteria, viruses and parasitic protozoa and helminths (worms). The residual concentration of microorganisms in treated wastewater is variable depending on several factors including type of wastewater, the efficiency and degree of disinfection, substrate concentration in wastewater, storage temperature and length of storage. The greater resistance of viruses to most disinfection procedures and the possibility of chlorination breakdown increases the importance of the ability of the soil to remove organisms.

Extensive field observations indicate that bacteria and viruses are removed from wastewater as it moves through the soil. Removal of microorganisms is accomplished by filtration and adsorption. Because of their large size, helminths and protozoa are removed primarily by filtration at the soil surface. Bacteria can be removed by filtration in the soil as well as by adsorption. Coliform removal in the soil profile has been shown to be approximately the same when primary or secondary pre-application treatment is provided. Unless fissures or dissolution channels are present for organism transport, soil will remove bacteria and viruses within several inches or few feet. Fecal coliforms are normally absent after wastewater percolates through five feet of soil. Viruses are removed primarily by adsorption.

After filtration and adsorption, the organisms then die due to radiation, desiccation, predation by other microorganisms and exposure to the adverse conditions in the soil. It is not expected that the presence of microorganisms in wastewater will be a limiting factor once wastewater has entered the soil, with the exception of animal grazing. See Section 6 for further discussion on grazing management.

To help minimize the exposure of receptors to microorganisms from land treatment system operations, land application methods should be conducted to minimize aerosol drift off site. Disinfection is required if human waste is treated and the fecal coliform concentrations exceed 200/100 ml. In addition, disinfection is required for wastewater applied to crops which are to be directly consumed by humans (see Section 6 for tables of microbial wastewater quality and buffer zone requirements, and IDAPA 58.01.17 for regulatory requirements. It is encouraged that crops which will be directly consumed by humans not be irrigated with wastewater.

Note: Phosphorus guidance revised as text, not a policy document, below

4.8 Phosphorus

The purpose of Section 4.8 is to provide the Idaho Department of Environmental (DEQ) permit writers with one approvable approach to dealing with protection of surface water from phosphorus when more specific information is not available.

Certain wastewater land treatment facilities, industrial facilities in particular, may generate appreciable quantities of phosphorus in wastewater streams. Many of these facilities have opted to land treat their wastewater. Since there are unique environmental considerations with respect to treatment of these wastewater streams, it is important to provide additional guidance to promote appropriate design, implementation and successful operation of these land treatment facilities.

4.8.1 Discussion

Phosphorus (P) is a required crop nutrient. It is also a major contributor of pollution to streams, causing algae blooms, low dissolved oxygen, undesirable plant growth, and fish kills. Phosphorus can reach streams by runoff from sites or inflow from aquifer recharge of the stream. Phosphorus has been implicated in the pollution of surface waters throughout the U.S., including Idaho. Phosphorus leaching from wastewater land application sites may present a risk of contamination to surface water depending on site-specific hydrologic conditions. In order to protect surface waters from the effects of excess phosphorus, surface runoff and deep percolation of phosphorus must be controlled. Surface runoff can contain significant amounts of dissolved and precipitated phosphorus. Phosphorus applied to the soil surface can be stored in the soil profile by precipitation and adsorption to soil particles. Eventually with significant P loading P can migrate to lower soil levels and even below the root zone. Once it goes beyond the root zone the P is unavailable for crop uptake and the coarser soil particles do not sorb significant quantities of P. Ground water will then begin to carry P from the site to other areas.

The concern for phosphorus contamination of surface water should be addressed in the development of wastewater land application permits. Applying runoff control technologies to limit surface runoff can prevent or mitigate environmental impacts related to surface runoff. Examples of these practices include applying water or wastewater at a rate less than the infiltration capacity of the soil, uniform sprinkler application, and using berms, ponds, and other runoff control structures. Controlling the application, soil accumulation, and leaching of phosphorus can prevent or mitigate impacts to surface water from ground water interconnections.

4.8.2 Guidance Recommendations

4.8.2.1 Phosphorus Guidelines

The Wastewater Land Application Permit Program recommends the following process to manage the risk of surface water being impaired by phosphorus applied to land application sites. This approach is designed to assure compliance with surface water quality standards for nutrients.

4.8.2.1.1 To address surface runoff concerns the following should be applied.

(1) The irrigation system must be designed such that no runoff of wastewater leaves the land application site or facility.
(2) Runoff controls and Best Management Practices (BMPs) should be established such that runoff of stormwater is only possible after storm events greater than the 25 year 24 hour storm event.

(3) Site closure plans should include consideration of accumulated phosphorus in the surface soils. Soil P upon completion of closure must not pose a threat to surface waters as a result of future irrigation practices or lack of adequate runoff control structures.

4.8.2.1.2 To address ground water interconnection with surface water the following approach is suggested

(1) Site-specific analysis, information, or other justification may be available that indicates that there is no ground water concern with respect to surface water. In the absence of this information the following goals should be considered for the ground water and the soil when preparing the WLAP permit.

- Ground water concentrations at down-gradient compliance wells should be less than 0.1mg/l total phosphorus. However, if up gradient ground water is greater than 0.1 mg/l, no increase in total phosphorus should occur at down gradient compliance wells.
- Achievement of any alternate goal, based on a ground water phosphorus allocation contained in a Total Maximum Daily Load (TMDL), should be attained.
- Soil phosphorus values measured in the 24"-36" soil depth level should be less than the following.
  - 20 ppm P Olsen method[1] or 25 ppm Bray method[2] if ground water is less than 5 feet from the ground surface
  - 30 ppm P Olsen method or 50 ppm Bray method if ground water is greater than 5 feet from the ground surface

(2) If phosphorus levels exceed the goals established, then one of the following courses of action should be taken.

- A permit holder may prepare a site-specific analysis that demonstrates an alternative limit or approach is protective of potentially impacted surface waters. Upon approval by DEQ, this alternate limit or approach may be incorporated into the permit or otherwise used as appropriate.
- In the absence of any site-specific analysis and alternate limits or approaches approved by DEQ, a permit limitation for phosphorus loading should be considered at 100% of crop uptake.

[1] "Olsen" refers to the Olsen ($NaHCO_3$ extractant) method for determining plant available soil phosphorus. This method is applicable to calcareous soils with >2% CaCO3. See "Methods of Phosphorus Analysis for Soils, Sediments, Residuals, and Waters," Southern Cooperative Series Bulletin No. 396.

[2] "Bray" refers to the Bray method for determining plant available soil phosphorus. This method is applicable to acid and neutral soils with < 2% CaCO3. See "Methods of Phosphorus Analysis for Soils, Sediments, Residuals, and Waters," Southern Cooperative Series Bulletin No. 396.

4.8.2.2 Monitoring of Phosphorus

Soil monitoring for plant available phosphorus using the methods described in Section 3.1.2(2) appropriate for the soil type will normally be required. Soil sampling frequency and depth intervals to be sampled should be specified by DEQ in the WLAP permit.

Ground water monitoring for total phosphorus will normally be required. Frequency and locations for monitoring should be specified by DEQ in the WLAP permit.

4.8.2.3 Determining Compliance with WLAP Permit Phosphorus Limits

Standard WLAP permit templates for municipal sites include limits on the amount of phosphorus that can be applied to the land application site.

The WLAP permit limits are variable dependent upon site specific conditions:

Parameter	Permit Limit
Phosphorus	125% of typical crop uptake 125% of uptake values from standard tables; or Use of University of Idaho Fertility Guides

In order to determine compliance with 125% of typical crop uptake, for example, take the following steps:

1. Calculate the phosphorus uptake by the crop or crops harvested from each hydraulic management unit on the site for the three most recent years of data plant tissue data. Select the median value from these data and multiply by 1.5. This is the loading limit. (in pounds per acre)

To determine the permit limit for phosphorus using standard tables, find the crop type in Section 7.6. and look up the phosphorus content. Then multiply by crop yield (per acre) and by 1.5. This is the loading limit based on a standard table. If the crop grown at the site is not included in Section 7.6, contact DEQ to get nutrient uptake for the crop being grown or consult the following Idaho Department of Agriculture website: http://www.nass.usda.gov/id/publications/annual%20bulletin/annbulltoc.htm.

Note that the permit limit may change from year to year as the crop type changes or the crop yield changes.

2. Calculate the amount of nutrients applied by wastewater application or from other sources, such as supplemental fertilizers (in pounds per acre). To make this calculation, the following information is required:
   a. Volume of wastewater applied, gallons/year
   b. Wastewater quality in mg/l. Use total phosphorus
   c. The amount of supplemental phosphorus fertilizer applied or any other nutrient sources (pounds per acre)
   d. Calculate wastewater P loading from wastewater volume, concentration, and site acreage, and then sum wastewater and fertilizer loading rates to obtain total P loading.
3. Compare the permit limit calculated in Step 1 above to the amount of phosphorus applied calculated in Step 2 to determine compliance.

Example calculations are provided below.

4.8.2.4 Example Calculations

Example 1

Crop type: Alfalfa Hay
Crop yield: 4.5 tons/acre
Wastewater applied to land application field: 6 million gallons
Land application area: 20 acres
Wastewater total-phosphorus: 5 mg/l (ppm)
No supplemental fertilizer applied

1a. Calculate crop uptake of phosphorus

For alfalfa hay, the phosphorus uptake (from Table 7-26 Section 7) is 4.72 pounds per ton of yield.

Phosphorus uptake: 4.5 tons/acre x 4.72 pounds N/ton = 21.24 pounds/acre

1b. Calculate the phosphorus permit limits (125 % of crop uptake)

Phosphorus application-permit limit: 21.24 x 1.25 = 27 pounds/acre
(round off to nearest whole number)

2. Calculate the amount of phosphorus applied with the wastewater

Phosphorus: $\frac{6\ \text{MG}}{\text{year}} \times 5\ \text{mg/L N} \times \frac{8.34\ \text{pounds/MG}}{1\ \text{mg/L}} \times \frac{1}{20\ \text{acres}} = 12.5\ \frac{\text{lbs}}{\text{acre}}$

3. Compare phosphorus applied versus the permit limit to determine compliance

	Permit Limit 125% of crop uptake	Amount applied	In compliance with permit limit?
Phosphorus	27 pounds/acre	12.5 pounds/acre	Yes

Example 2

Crop type: Forest Site (pine tree)
Crop yield: Harvest per silvicultural plan
Wastewater applied to land application field: 14 million gallons
Land application area: 26 acres
Wastewater total-phosphorus: 4 mg/l (ppm)
No supplemental fertilizer applied

1a. Calculate crop uptake of phosphorus
From Table 7-26, Section 7, for tree sites, the phosphorus uptake allowance is 20 pounds per acre.

1b. Calculate the phosphorus permit limits (150% of crop uptake)
Phosphorus application permit limit: 20 x 1.25 = 25 pounds/acre
(round off to nearest whole number)

2. Calculate the amount of phosphorus applied with the wastewater
Phosphorus: $14\ \frac{\text{MG}}{\text{year}} \times 4\ \text{mg/L N} \times \frac{8.34\ \text{pounds/MG}}{1\ \text{mg/L}} \times \frac{1}{26\ \text{acres}} = 18\ \frac{\text{lbs}}{\text{acre}}$

3. Compare phosphorus applied versus the permit limit to determine compliance

	Permit Limit 125% of crop uptake	Amount applied	In compliance with permit limit?
Phosphorus	25 pounds/acre	18.0 pounds/acre	Yes

4.8.3 Reference

Methods of Phosphorus Analysis for Soils, Sediments, Residuals, and Waters. Southern Cooperative Series Bulletin No. 396.

4.9 Management of Total Dissolved Solids

Total Dissolved Solids (TDS) can be naturally occurring or man caused in ground water. Elevated levels of TDS are found in ground water in many areas of the state. Because of the need to protect ground water quality and sustain soil productivity WLAP facilities causing significant TDS impacts to ground water, or which pose a risk of causing significant impacts, should develop site specific TDS Management Plans. Plans should include, but not be limited to, the following:

a. identification of representative monitoring sites to measure TDS,

b. characterization of all known sources of inorganic TDS,
c. specification of alternatives to isolate and reduce TDS being generated or land applied,
d. evaluation of the expected improvements to ground water quality, and
e. e. an implementation schedule for TDS reduction

The approach described above is a passive remedial one and may not be appropriate for a facility that has or is currently impacting a ground water supply well. If a public water supply or a private water supply is contaminated by wastewater land treatment activities as described in IDAPA 58.01.11.400, actions on the part of DEQ and/or the facility may be indicated, also as described in Section 400.

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5. Not Used at This Time

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6. Operations

6.1 Pretreatment Considerations

The degree of pretreatment wastewater receives before land application can be a distinguishing factor in establishing site requirements. The necessary level of pretreatment can be site and/or wastewater specific. The main consideration is always whether the soil-crop system can treat the wastewater in question.

In some cases a change in the processing method could benefit the wastewater generator. If the process can significantly reduce the concentration of the land limiting constituent, increased loading of wastewater would be possible up to the point where the next land limiting constituent loading threshold is reached. Such processing changes would have to be evaluated as to their cost effectiveness (i.e., less land needed vs. cost of process change). However, more than one land limiting constituent may need to be reduced to allow higher loading rates.

6.1.1 Municipal Pretreatment

The primary concern regarding municipal wastewater treatment by land application is the potential health risk due to the presence of disease causing organisms. Most municipal wastewater will, therefore, require pretreatment that may include a considerable reduction of indicator organisms prior to land treatment. The degree of treatment will depend on the type and intended use of the crop, the method of wastewater application and extent of public access and exposure. Specific coliform treatment requirements for direct use of municipal wastewater are found in IDAPA 58.01.17.600.07.

Exceptions to the treatment requirements can be considered when it is demonstrated that the exception will not adversely impact protection of the public health and safety. This evaluation will include the participation of local health agencies and the affected public through their review and comment on the proposal. See Sections 4 and 6.6 for more information on this topic.

6.1.2 Industrial Pretreatment

Pretreatment requirements for industrial wastewaters will tend to be more variable than municipal wastewaters because there is often more diversity of critical wastewater constituents in these wastewater streams. Pretreatment will depend on its cost effectiveness in most cases. For example, additional treatment could reduce the land area needed to treat the wastewater. Metals, toxics, suspended solids, nitrogen and COD are examples of pollutants that may require additional treatment before the wastewater can be land-applied. Disinfection of industrial wastewaters is generally not required if it can be demonstrated that no sanitary sources of contamination exist and that the public health and safety will not be adversely affected.

6.2 Operation and Management Needs

6.3 Lagoons

This section discusses the purpose and need for wastewater storage structures at wastewater reuse facilities, design requirements, and seepage testing protocol.

6.3.1 Lagoons: Purpose and Need

Storage of wastewater is needed for some land treatment systems and other reuse systems. Wastewater generation and treatment plants can typically have one to several lagoons serving various purposes. The storage volume can vary from as little as one day's flow to as much as six months. Storage is needed when precipitation produces an excessive hydraulic load on the soil crop system; when cultivating practices prevent application; when winter weather conditions preclude operation; when flow variations in quantity and quality requires equalization; when winter weather forces a reduction in the rate of application; and as a backup for the treatment system under emergency situations. It is possible to reduce or remove storage requirements by providing alternative backup measures to be determined on a case-by-case basis.

The key elements to consider when determining storage requirements are the local climate and the period of operation. Storage is generally needed during the harsh winter months when application rates must be reduced. Evaluation of these elements helps to determine the needed storage volume. Analysis of rainfall data also helps identify the storage needs related to expected periods of excessive precipitation. Some storage may be necessary to retain certain storm events on the land treatment site to prevent runoff.

In some areas, and depending on wastewater characteristics, the winter weather may be mild enough to allow application during much of the winter. In these cases, consideration must be given to the trade-off of the cost of storage versus the cost of additional area for land application. See Section 4 for additional information on non-growing season application and storage practices. See also Section 6.8 for information on weed control around lagoons.

It is important for lagoons to be sufficiently sealed so that they do not become major contributors to the contamination of ground water. For this reason, members of the regulated community are required to demonstrate the integrity of their wastewater treatment and storage structures. The following provides guidance for methods to determine seepage rates for lagoon:

http://www.deq.state.id.us/water/assist_business/engineers/guidance/lagoon_seepage.pdf

Alternative methods may be submitted for review and approval DEQ.

6.3.2 Lagoons: Design Criteria

Design criteria for municipal and industrial lagoons are based on the *Ten State Standards* otherwise known as the *Recommended Standards for Wastewater Facilities – 2004* by the Great Lakes-Upper Mississippi River Board of State Sanitary Engineers pursuant to the *Idaho Water Quality Standards* (IDAPA 58.01.02.402). These design criteria for lagoons require lagoons be designed with a seal that has a seepage rate less than 500 gallons/acre-day (0.018 inches/day).

Performance criteria based on DEQ policy presently recommends lagoons be allowed to seep at a rate up to 3,400 gallons/acre-day (0.125 inches/day), or approximately seven times the design criteria. This rate is based on a perceived allowable error in physically measuring the seepage rate.

DEQ typically recommends that recent seepage data be submitted as part of the permit renewal application package each five years. Results of the seepage data will determine any permit conditions needed to update or modify existing lagoons.

If a properly tested lagoon leaks more than this 0.125 inches per day, the options for mitigation include 1) retesting the seepage rate immediately; 2) repair or replace or install liner and retest; or 3) develop a plan based on ground water sampling and analyses to determine the effect of the leakage on the local groundwater. If that impact does not comply with the *Ground Water Quality Rule*, then options 1 or 2 above remain.

6.4 Grazing Management

This section discusses grazing on wastewater land treatment sites, grazing plans, and special considerations regarding grazing on municipal land treatment sites.

6.4.1 General Discussion

Well managed livestock grazing is an effective method for harvesting crops grown on wastewater land treatment sites. Poorly managed livestock grazing on land treatment sites can result in negative environmental impacts and pathogen transmission to grazing animals if land applying municipal wastewater. For these reasons, the *Wastewater-Land Application Permit Regulations,* IDAPA 58.01.17.600.07 prohibit~~s~~ grazing on WLAP sites where municipal wastewater is applied. The intent of the regulations and the guidance is to discourage grazing altogether, as it may damage the site and the practice is difficult to regulate. However, DEQ does allow exceptions per some municipal sites as discussed in Section 6.4.3 below. DEQ allows grazing on non-municipal sites for fall clean-up of sites and growing season grazing, subject to certain conditions.

Livestock grazing management can avoid adverse impacts to the site and to the environment with careful consideration of: nutrient loading rates, compaction of the soil, damage to the irrigation system, and damage to the crop. Nutrient loading rates should be reduced (from those used for harvest sites) to match nutrient removal rates. For example, net nutrient removal should equal the crop nutrients consumed minus the nutrients deposited with the manure.

Soil compaction can cause decreased infiltration rates leading to increased potential for runoff and reduced plant growth. If animals are allowed on a land treatment site when soils are wet, substantial soil compaction can occur. This problem can be avoided by grazing when soil moisture is below field capacity.

Over-grazing of a site can decrease plant growth and vigor. Reduced plant growth decreases water and nutrient uptake, increasing the potential for deep percolation and contamination of ground water. Reduced plant vigor causes long term reduction in yields and the capacity of the site to support grazing. Over-grazing can be avoided by limiting the number of animals, limiting the time that animals remain on the field or plot, rotating livestock from plot-to-plot based on amount of remaining vegetation, and adhering to an approved grazing management plan.

6.4.2 Grazing Plans

A grazing management plan is required for any grazing occurring during the growing season. A grazing management plan is not required, but is recommended for a fall clean up operation. The purpose of a grazing management plan is to insure crop health and soil properties are maintained for effective wastewater land treatment. These plans should follow the guidance and specifications of relevant sections of the *USDA Natural Resource Conservation Service (NRCS) Field Office Technical Guidance* (FOTG). See the following Web site for the electronic FOTG (eFOTG):

http://www.nrcs.usda.gov/technical/efotg

Required grazing plans must be reviewed and approved by DEQ before being implemented. DEQ is also willing to review and approve non growing season grazing plans for fall clean up as time and resources allow, should facilities choose to write and submit a plan. One resource for developing grazing plans is the NRCS. Table 6-1 lists several practice names and codes from the FOTG whose specifications are relevant to grazing.

Table 6-1. Relevant FOTG Approved Grazing Specifications

Practice Name	Code	Where Applicable
Pasture and Hayland Management	510	Pasture land and hayland
Pasture and Hayland Planting	512	Pasture, hayland, or land converted from other uses
Grazing Land Mechanical Treatment	548	Native grazing land
Planned Grazing Systems	556	Range, pasture, hayland, woodland, wildlife land
Proper Grazing Use	528	Range, native pasture, grazed wildlife land
Proper Woodland Grazing	530	Wooded areas

USDA SCS FOTG, 1986

6.4.2.1 Conditions for all WLAP Grazing

All WLAP site grazing is subject to the following conditions:

- Livestock should be on site only until feed is reasonably depleted; minimum leaf heights and stubble heights before and during grazing should be observed. (see Table 6-2, from Soil Conservation Service Idaho Field Office Technical Guide Pasture and Hayland Management 510-6, Table 1, September 1986.)
- There should be no irrigation while livestock are on site.
- Livestock should be removed if precipitation wets soil such that soil/crop damage may result. (see soil moisture determination).
- 4A written statement is needed by DEQ from the permittee stating that the permittee has control over the management of the grazing animals.
- There should be no supplemental feeding of livestock while on the WLAP site, unless DEQ approves such feeding in writing.

Table 6-2. Growth Stage for Harvesting Forage

Column A Plant Species - Common Name	**Co1umn B** Minimum Leaf Length Reached Prior To InitIating Grazing (in.)	**Column C 1/** Minimum Stubble Height to Remain. Following Grazing Or Hay Harvesting (in.)
Kentucky bluegrass	6	3
Smooth bromegrass	8	4
Regar bromegrass	8	4
Reed canarygrass	10	6
Tall fescue	8	4
Orchardgrass	8	4
Timothy	8	4
Garrison creeping foxtail	10	4
Tall wheatgrass	10	8
Intermediate wheatgrass	10	4
Pubescent wheatgrass	8	4
Siberian wheatgrass	6	3
Crested wheatgrass	6	3
Russian wildrye	8	4
Alfalfa	14	3
Ladino clover	8	3
Red clover	6	3
Alsike clover	6	3
Sweet clover	8	4
Trefoil	8	3
Sainfoin	12	6
Milkvetch	8	4
White dutch clover	4	2

1/ This is the minimum stubble height to be remaining at end of grazing period or hay harvest operation. When a grass-legume mixture is harvested for hay, generally use most limiting stubble height for the mixture.

In the event there is a significant precipitation event (standing water or muddy conditions are signs) while livestock are on the site, a determination of soil moisture should be made to assess whether crop damage and/or soil compaction will result. Soils can be sampled after the precipitation event and evaluated for soil moisture according to Table 6-3.

“The feel method involves collecting soil samples in the root zone with a soil probe or spade. Then, the water deficit for each sample is estimated by feeling the soil and judging the soil moisture as outlined in …” the table below. “Soil samples should be taken at several depths in the root zone at several places in the field.” (Taken from Wright and Bergsrud, 1991).

Table 6-3. Guide For Judging Soil Water Deficit Based on Soil Free and Appearance for Several Soil Textures (Wright and Bergsrud, 1991)

SOIL TEXTURE CLASSIFICATION

Moisture deficiency **in/ft**	*Coarse* *(loamy sand)*	*Sandy* *(sandy loam)*	*Medium* *(loam)*	*Fine* *(clay loam)*	*Moisture deficiency* **in/ft**
.0	*(field capacity)* *Leaves wet outline on hand when squeezed*	*(field capacity)* *Appears very dark, leaves wet outline on hand, makes a short ribbon.*	*(field capacity)* *Appears very dark, leaves wet outline on hand, will ribbon out about one inch.*	*(field capacity)* *Appears very dark, leaves slight moisture on hands, when squeezed, will ribbon out about two inches.*	**.0**
.2	*Appears moist, makes a weak ball*				**.2**
.4	*Appears slightly moist, sticks together slightly.*	*Quite dark color, makes a hard ball.*	*Dark color, forms a plastic ball, slicks when rubbed.*	*Dark color, will slick and ribbons easily.*	**.4**
.6	*Appears to be dry, will not form a ball under pressure.*	*Fairly dark color, makes a good ball.*	*Quite dark, forms a hard ball.*	*Quite dark, will make thick ribbon, may slick when rubbed.*	**.6**
.8		*Slightly dark color, makes a weak ball.*	*Fairly dark, forms a good ball.*	*Fairly dark, makes a good ball.*	**.8**
1.0	*Dry, loose, single-grained flows through fingers.* *(wilting point)*	*Lightly colored by moisture, will not ball.*	*Slightly dark, forms weak ball.*	*Will ball, small clods will flatten out rather than crumble.*	**1.0**
1.2		*Very slight color due to moisture, loose, flows through fingers.* *(wilting point)*	*Lightly colored, small clods crumble fairly easily.*		**1.2**
1.4			*Slight color due to moisture, powdery, dry, sometimes slightly crusted but easily broken down in powdery condition.* *(wilting point)*	*Slightly dark, clods, crumble.*	**1.4**
1.6				*Some darkness due to un-available moisture, hard baked, cracked sometimes has loose crumbs on surface.* *(wilting point)*	**1.6**
1.8					**1.8**
2.0					**2.0**

Table 6-4. Generalized Drainage Times for Uniform Soil Profiles of Varying Textures

Texture	Drainage Time (Range in days)
Loamy Sand	0.5 - 2
Sandy Loam	3 - 4
Silt Loam	4 - 6
Clay Loam	5 - 7

Carlisle and Phillips, 1976 and Donahue et al., 1977

6.4.2.2 Conditions for Growing Season Grazing

When developing a grazing management plan specifically for the growing season, the following items should be included:

- Specify the type and number of animals to be grazed on the site.
- Identify when animals can be put on a plot and when they should be taken off based on plant growth characteristics (plant height or other criteria). Indicate the primary growing season or months anticipated for the grazing season.
- Provide a schedule for rotating the animals through the site. Include a map showing plot arrangement, location of salt blocks, protein blocks, and water. The grazing management plan should include a schedule for rotating the location of any salt or protein blocks to prevent excessive traffic on any portion of the site.
- Work out a nutrient balance, which accounts for crops grown, yield, nutrients removed and added by livestock.

6.4.2.3 Conditions for Fall "Clean-Up" (Non-Growing Season)

If a WLAP site is to be grazed solely for the purpose of fall "clean-up" of the site, then the following conditions should be met:

- Livestock should be on site only after harvest.
- Livestock should be off site no later than December 31st.
- No winter pasturing of livestock, or supplemental feeding.

6.4.3 Grazing on Land Application Sites Irrigated with Treated Municipal Wastewater

This section establishes program guidance on the practice of using treated municipal wastewater to irrigate sites grazed by animals used for dairy or meat production. The Idaho State Department of Agriculture (ISDA) and the Idaho Division of Environmental Quality (DEQ) jointly developed this guidance.

In February 1990, Idaho DEQ established program guidance to disallow grazing on all land application sites using treated municipal wastewater. The primary reasons cited for this decision were 1) the potential public health risks and 2) the limited resources of the agency to reasonably insure compliance with grazing management plans.

Recently, several municipalities have inquired if grazing animals on new land application sites would be acceptable. EPA guidance (1992) and recent regulations developed by neighboring States indicate grazing is acceptable under certain conditions. Therefore, DEQ drafted a recommendation for grazing municipal sites and sought comments from ISDA and the District Health Departments. ISDA indicated they had several animal health concerns in regards to the draft guidance.

ISDA and DEQ formed a working committee to revise the draft guidance to address potential health risks, to both humans and grazing animals. Guidance provided in Table 6-5 is the mutual recommendation of ISDA and DEQ.

Table 6-5. Grazing on Municipal Wastewater-Land Applications Sites

Category	Type of Wastewater	Grazing allowed on land application site?
I	Municipal wastewater that is oxidized, coagulated, clarified, filtered, or treated by an equivalent process and disinfected to 2.2 total coliform organisms per 100 ml [1]	yes [2, 3]
II	Municipal wastewater that is oxidized and disinfected to 2.2 total coliform organisms per 100 ml [1]	Dependent on analysis of specific proposal [2, 3, 5]
III	Municipal wastewater that is oxidized and disinfected to 23 total coliform organisms per 100 ml [1]	Dependent on analysis of specific proposal [2, 4, 5]
IV	Municipal wastewater that is oxidized and disinfected to 230 total coliform organisms per 100 ml [1]	no
V	Municipal wastewater that is oxidized, no disinfection	no

1. Median total coliform count is based on bacteriological results of the last 7 dates for which analyses have been completed. A minimum chlorine residual of 0.5 mg/l is recommended in the applied wastewater for systems using chlorine to disinfect. Following disinfection, no further wastewater input allowed (piped distribution).
2. DEQ approved grazing management plan required. See Section 6.4.2 for information on grazing management plans.
3. For Categories I and II, a minimum waiting period of 0.5 to 7 days prior to grazing pasture irrigated with wastewater is required to allow for soil drainage and pathogen die-off. Generalized drainage times for various soils are given in Table 6-4 above.
4. For Category III, the recommended minimum waiting period prior to grazing is 15 to 30 days depending on soils, drainage times and pathogen die-off. See also Table 6-4 for generalized drainage times.
5. All odor provisions are also applicable. See Section 2.4.2 for further discussion of odor and other nuisance conditions.

6.4.4 References

Carlisle, B. L., and J. A.Phillips, June 1976. Evaluation of Soil Systems for Land Disposal of Industrial and Municipal Effluents. Dept. of soil Science, North Carolina State University.

Donahue R. L., R. W. Miller, and F. C. Shickluna., 1977. Soils – An Introduction to Soils and Plant Growth (4th Edition). Prentice Hall, 626 pages.

USDA Natural Resource Conservation Service. Field Office Technical Guides (FOTG). See the following web site for the the electronic FOTG (eFOTG) (http://www.nrcs.usda.gov/technical/efotg)

Wright, Jerry, and Fred Bergsrud. 1991. Irrigation Scheduling. Minnesota Extension Service publication no. AG-EO-1322-C.

6.5 Buffer Zones

Buffer zones provide distance between the boundary where wastewater-land application ceases and dwellings, public or private water supplies, surface water, or areas of public access.

Buffer distances are established to protect 1) the public from unnecessary exposure to land applied wastewater, and 2) drinking water supplies and surface water.

This section presents general buffer zone guidance, and more specific guidance applicable to municipal and industrial wastewater land treatment facilities. Also presented are criteria for alternative industrial wastewater buffer zone distances.

6.5.1 General Buffer Zone Distances

The following are general recommendations for buffer zones from wastewater land treatment sites to various land use features. These distances should be considered to protect against the potential for aesthetic and public health impacts.

- A land treatment system should not be located closer than 300 feet from the nearest inhabited dwelling.
- A land treatment system should not be located closer than 1,000 feet from a public water supply well or 500 feet from a private water supply well used for human consumption.
- A minimum of 50 feet should be provided between the wastewater application site and areas accessible by the public.
- The distance from permanent or intermittent surface water other than irrigation ditches and canals from the treatment site should be 100 feet.
- A 50 foot separation distance should be provided between the land treatment site and temporary surface water and irrigation ditches and canals.

- A map should be prepared and submitted to DEQ indicating the location of the land treatment system and the location of all wells, wetlands, streams, canals, and lakes within 1/4 mile of the treatment site.

6.5.2 Municipal Wastewater Buffer Zones

Expanded guidance for municipal wastewater is found in Table 6-6. There are sixteen different scenarios, scenarios A through P, which can be used for existing and new land application systems. To use the table, read vertically, factoring in the appropriate conditions. For example, Scenario D uses a municipal wastewater with effluent of advanced secondary quality; the WLAP site is in a residential area; and the wastewater is sprinkle irrigated. Continuing down the column, buffer zones and posting requirements are given.

Table 6-6. Municipal Wastewater Buffer Zone Treatment Sites

SITE CONDITION	**SCENARIOS**															
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**	**N**	**O**	**P**
DEGREE OF TREATMENT																
Primary Undisinfected with org TNTC (1)	X				X				X				X			
Primary Disinfected to 230 org/100 ml (1)		X				X				X				X		
Secondary Disinfected to <23 org/100 ml(1)			X				X				X				X	
Advanced Secondary Disinfected to <2.2 org/100 ml (1)				X				X				X				X
LOCATION:																
Suburban or Residential Area	X	X	X	X					X	X	X	X				
Rural or Industrial Area					X	X	X	X					X	X	X	X
MODE OF IRRIGATION																
Sprinkler Irrigated	X	X	X	X	X	X	X	X								
Furrow Irrigated									X	X	X	X	X	X	X	X
RESULTING BUFFER ZONE REQUIREMENTS:																
BUFFER ZONE BETWEEN:																
Site and Inhabited Dwellings	1000 ft	1000 ft	300 ft	100 ft	1000 ft	1000 ft	300 ft	100 ft	300 ft	300 ft	50 ft	50 ft	300 ft	300 ft	50 ft	50 ft
Site and Areas Accessible to Public	1000 ft	500 ft	50 ft	0 ft	1000 ft	300 ft	0 ft	0 ft	100 ft	100 ft	0 ft	0 ft	50 ft	50 ft	0 ft	0 ft
FENCING TYPE																
Cyclone w/Barbed Wire									X	X						
Woven Pasture Fence	X	X	X		X						X		X	X		
Three-Wire Pasture Fence						X	X									
None Required				X				X				X			X	X
POSTING																
Required (2)	X	X			X	X			X	X			X	X		
Required (3)			X	X			X	X			X	X			X	X

(1) Bacteria count represents the total coliform bacteria as a median of the last 7 days of bacteriological sampling for which analysis have been completed
(2) Signs should read 'Sewage Effluent Application - Keep Out' or equivalent to be posted every 500 feet and at each corner of the outer perimeter of the buffer zone(s) of the site
(3) Signs should read 'Irrigated with Reclaimed Wastewater - Do Not Drink' or equivalent to be posted every 500 feet and at each corner of the outer perimeter of the buffer zone(s) of the site

6.5.3 Industrial Wastewater Buffer Zones

Buffer zones for industrial wastewater apply to both existing land application systems and to all new systems to protect public health and prevent aesthetic impacts or public nuisance conditions (Table 6-7). The 300 foot and 50 foot buffer zones are used as typical distances for industrial wastewater(s). To use the table, read vertically, factoring in appropriate site or facility conditions.

Table 6-7. Industrial Buffer Zone Scenarios.

SITE CONDITION FOR INDUSTRIAL WASTEWATER	SCENARIOS			
	A	B	C	D
LOCATION				
Suburban or Residential Area	X	X		
Rural or Industrial Area			X	X
MODE OF IRRIGATION				
Sprinkler Irrigated	X		X	
Furrow Irrigated		X		X
RESULTING BUFFER ZONE REQUIREMENTS:				
BUFFER ZONE BETWEEN:				
Site and Dwellings	300 ft	300 ft	300 ft	300 ft
Site and Areas access. to Public	50 ft	50 ft	50 ft	0 ft
FENCING TYPE				
Three-Wire Pasture Fence	X	X		
Not Required			X	X
POSTING				
Required (1)	X	X		
Not Required			X	X

(1) Signs should read 'Irrigated with Reclaimed Wastewater - Do Not Drink' or equivalent to be posted every 500 feet and at each corner of the outer perimeter of the buffer zone(s) of the site.

There may be instances when the buffer zones are overly protective for a particular facility or site and if so, then the permittee may use the prescribed criteria that follows in Section 6.5.4 to propose alternative buffer zones. Likewise, DEQ may require greater distances for buffer zones, for example, if the wastewater is of the same quality as raw or primary sewage. Applicants are encouraged to provide justification alternative buffer zones prior to system design. All buffer zones must comply with, local zoning ordinances.

6.5.4 Criteria for Alternative Wastewater Buffer Zones

If a buffer zone is considered unreasonable or unnecessary for a specific site, it is incumbent upon the permittee to propose an alternative distance and justify this proposal to DEQ. The alternative distance proposal should be specific to a given site and should demonstrate how public health and the waters of the state will be adequately protected. Additional information to consider when proposing an alternative buffer zone may include but is not limited to the items listed below:

- Provide a higher degree of pretreatment for wastewater, such as oxidation, anaerobic treatment, disinfection or filtration, prior to applying to land surface.
- Show how alternative methods of irrigation such as low pressure sprinkler irrigation will reduce spray or air borne exposure from drift[3].
- Provide a physical or vegetative barrier that has been adequately designed to reduce drift or aerosol[1] dispersion. A vegetative barrier should provide adequate buffer capability for the seasons the wastewater is being applied. See Spendlove, et al., (1979/1980), for one example of how to design vegetative barriers.
- Determine the wind speed and direction on a site specific basis to verify when spraying by pressure irrigation can take place.
- Conduct a pathogen study of wastewater showing levels of pathogens under typical operating conditions.
- Demonstrate how using either best practical methods, approved best management practices or best available technology can effectively minimize impacts to public health and waters of the state.

Alternative wastewater buffer zone proposals submitted by the permittee may include from one to all six items listed above depending upon what is necessary. The above list is not intended to denote any particular ranking or prioritization of items but rather is intended to present a number of possible options.

6.5.5 References

Kincaid, D. 1995. Personal communication from Kincaid to DEQ in 1995

Spendlove, J. C., R. Anderson, S. J. Sedita, P. O'Brian, B. M. Sawyer and C. Lue-Hing. 1979/1980. Effectiveness of Aerosol Suppression by Vegetative Barriers. *in* Wastewater Aerosols and Disease, EPA 600/9-80-028, Cincinnati, Ohio, H. Pahren and W. Jakubowski, editors 1979/1980

6.6 Protection of Domestic and Public Well Water Supplies

This section discusses regulatory programs which serve to protect well water supplies. Also discussed is well water supply protection for those wells in the vicinity of wastewater land treatment facilities.

[3] Drift is typically considered to be those droplets greater than 200 microns in size and aerosol is generally considered to be droplets less than 200 microns in size (Kincaid, 1995, ARS, Kimberly, Idaho.)

6.6.1 Wellhead Protection Areas

The Amendments to the *Safe Drinking Water Act* of 1986 authorized the Wellhead Protection Program for states to develop and implement for protection of ground water and drinking water supply systems. The Wellhead Protection Program is intended to supplement the existing drinking water rules and drinking water standards. As such, local communities can use the state Wellhead Protection Program as the minimum criteria upon which they can design their own protection program based on local conditions. Idaho's Wellhead Protection Program is using a voluntary approach so that while implementing a local Wellhead Protection Program is encouraged, it is not mandatory. DEQ is designated to provide technical assistance and guidance on the Wellhead Protection Program to local governments and water system purveyors.

Since each community can choose to develop a Wellhead Protection Plan as additional protection beyond what is required by the Rules Governing Drinking Water, it is recommended that a WLAP permittee contact either their city/county government or water purveyor if uncertain on established or developing local wellhead protection programs. Such wellhead or wellfield protection areas may be more restrictive than the wellhead setback distances discussed below (Section 6.6.3) and in Section 6.5 above. Refer to Section 15.14. **below** for special considerations on wellhead protection areas and wastewater land treatment systems overlying the Rathdrum Prairie Aquifer. A copy of the Idaho Wellhead Protection Plan (DEQ, 1997) may be requested from DEQ.

The site specific questions pertaining to the siting of wells and wastewater land treatment sites with respect to each other are many and are discussed in more detail below. Before discussion of physical site specific factors, it must be noted that local zoning considerations are perhaps one of the major concerns with designating wellhead protection areas. *It is the responsibility of the WLAP permittee or applicant to inquire of appropriate planning and zoning jurisdictions and local governing bodies whether their site is within a wellhead protection area*. If so, local ordinances and planning and zoning requirements are to be taken into account and, where stricter than state regulations, are to be used in the design of the facility and in the siting of wells and treatment sites.

6.6.2 Domestic Water Supplies

A permit to construct a well is required by the Rules and Regulations, Well Construction Standards (IDAPA 37.03.09) administered by the Idaho Department of Water Resources. This permit applies to all water wells including domestic wells (individual, public, and non-public wells), irrigation wells, monitoring wells, and low temperature geothermal wells. The same permitting requirements apply to wells that are drilled to augment or replace existing wells.

Placement of wells in relation to potential sources of contamination, such as wastewater-land application systems, is addressed by DEQ or the District Health Department, depending on the source of contamination and/or the land use activity.

If the well supplies a public drinking water system (see the Drinking Water Rules, IDAPA 58.01.08), then maintaining the structural integrity of the distribution system and determining the quality of water in the system comes under the jurisdiction of DEQ for a system with 25 or more connections, or serving 25 or more individuals. Wells come under the jurisdiction of the local District Health Department if supplying a public water supply system with 15 through 24 connections, non public water supply systems with 2-14 connections or an individual domestic well.

6.6.3 Protection of Well Water Supplies Near Wastewater Land Treatment Facilities

Section 6.5 above recommends buffer zones of 500 feet between domestic wells and a wastewater land treatment site and 1000 feet between the latter and a municipal water supply well. Applicants may choose to use these recommended distances, or they may choose to evaluate respective locations of wastewater land treatment sites and wells using the well location acceptability analysis. Known water quality problems associated with an area or existing site may preclude the use of the distances provided in Section 6.5 above.

The discussion that follows on Well Location Acceptability Analysis, considers the hydrogeological setting, well construction; and the management, operation, and loading of the land treatment site to determine suitability of respective locations of water supply wells and land treatment acreage. This guidance may also be used to determine location suitability of irrigation wells and injection wells; not to protect a supply of water yielded for consumption by these wells, but rather to prevent the irrigation or injection well from acting as a conduit allowing the land applied wastewater to reach the aquifer.

The sections below describe Well Location Acceptability Analysis protocol. Also discussed are descriptions and methods to conduct capture and mixing zone analyses.

6.6.3.1 Well Location Acceptability Analysis

Figure 6-1 is a decision flow chart, which provides guidance on the acceptability of domestic private, shared (non-public) or municipal (public) well locations with respect to wastewater land treatment sites and the potential adverse impacts the latter may have on potable water supplies. Generally, whenever a location for a well is termed acceptable, this means the wastewater land treatment site is not causing contamination of the aquifer and the beneficial uses of the ground water pumped from the well are maintained. The wastewater-land application permit may require monitoring of said well to substantiate that contamination is not occurring at present or in the future. When Figure 5 states "Well Site Location Not Acceptable" it means that the relative positions separating the planned or actual wastewater land treatment site and an existing or planned well is unacceptable.

The first question in the flow diagram asks whether the well is closer than 1/4 mile from the site. This question establishes an initial universe of wells to consider the suitability of the wastewater-land application site in relationship to wells. If the well is not within 1/4 mile, it is generally not considered, but can be, depending on site specific conditions.

If a well is closer than 50 feet from the wastewater land treatment site, the location is not acceptable, according to the *Rules Governing Drinking Water*, IDAPA 58.01.08.550.02a. The same protection is provided for all domestic water systems whether an individual, non public or public water supply system. Based on required distances in the drinking water regulations for other types of sewage systems (IDAPA 58.01.08.900.01), a 100 foot separation distance is considered an appropriate separation distance between a well and a municipal wastewater-land application site. In the event the wastewater land treatment site is not applying municipal wastewater or the well is farther than 100 feet, then questions regarding the nature of the aquifer follow.

If the well is completed in a confined aquifer, and both the integrity of the confining layer(s) and well construction are documented, then generally the location is acceptable. If the well is not completed in a confined aquifer, or is not adequately constructed in the same, or if the nature of the confining layer is not documented, the well is regarded to be in a shallow water table aquifer.

The next question asks whether the wastewater land treatment site is an existing one or not. If it is not an existing site, but a proposed site, then a Capture Zone Analysis (CZA) is done where time (t) = 5 years. A capture zone analysis is done to see if the boundaries of a wastewater-land application site overlie~~s~~ the delineated zone from which the well draws water. A capture zone, or zone of contribution as it is sometimes called, is defined as the area surrounding a pumping well that supplies ground water recharge to the well (EPA 1991) (see further discussion below in Section 6.6.3.2.

The question which follows asks whether the wastewater land treatment site lies within the five year capture zone. If it does not, the well wastewater land treatment site location is acceptable for the five year life of the permit. The reasoning being that if the proposed site is predicted to cause ground water contamination, or actually does cause contamination, that the well would be safe from those impacts for five years.

EDITOR’S NOTE: But after 5 years, the contamination plume generated from the site would intercept the well. The well would show contamination during the time that the plume passes the well. If the facility changes operations and loading rates to halt continued contamination, there will be a lag time measured in years before the well water quality would again reflect non-contaminated conditions. If the facility does not change operations, the well will likely continue to be contaminated. The left leg of the Figure 5 flow chart should be deleted, and there should be no question regarding, nor distinction made between, existing or proposed sites.

If the wastewater land treatment site lies within the five year capture zone, and municipal wastewater is applied, the well/site location is not acceptable. A five year travel time has been set as a protective minimum for attenuation of pathogens potentially introduced into the aquifer from wastewater land treatment sites.

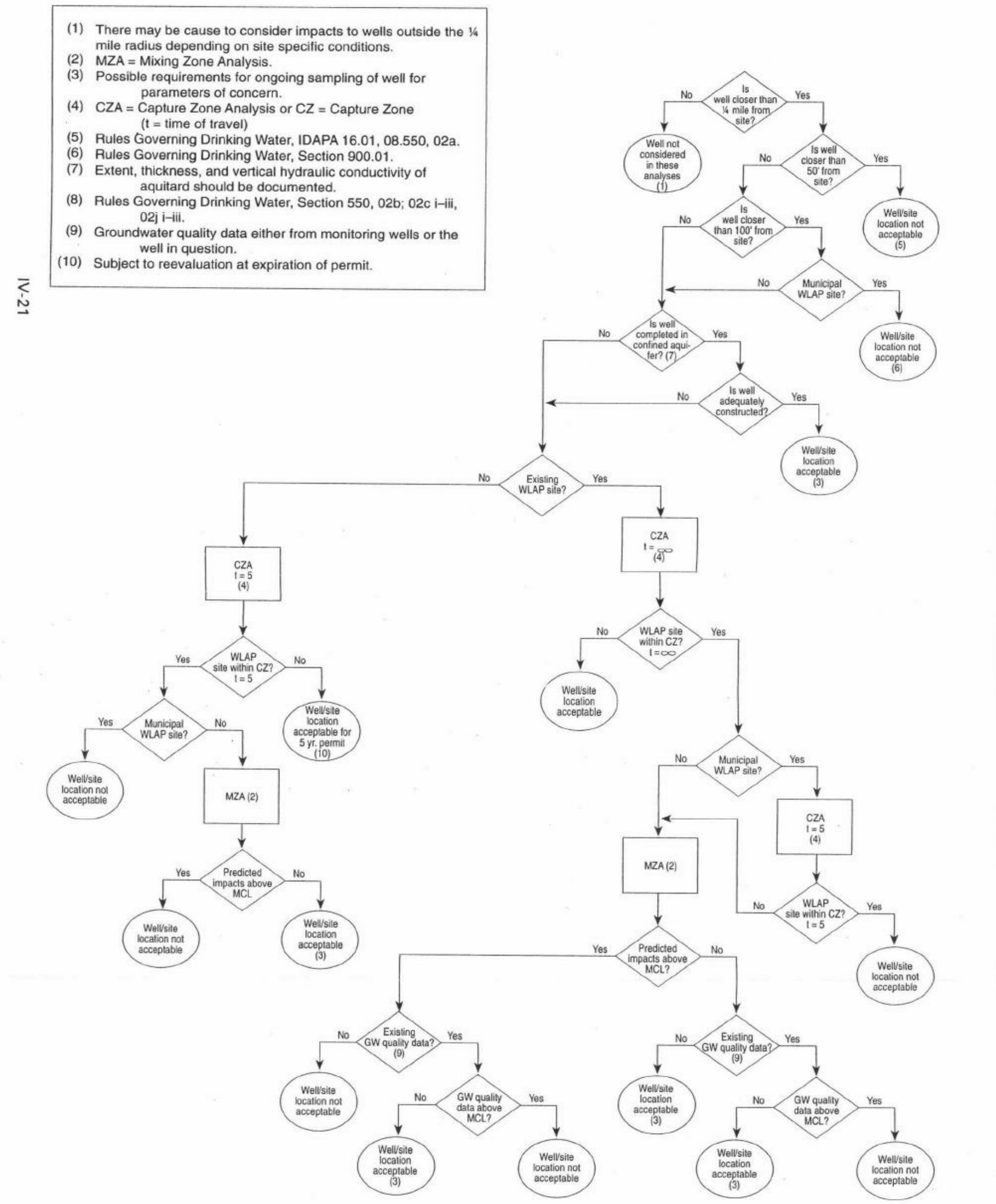

Figure 6-1. Well Location Acceptability Analysis.

If the site is not a municipal site, and yet is within the five year capture zone, a mixing zone analysis (MZA) is done to determine whether predicted impacts from the wastewater land treatment site exceed water quality standards or compromise beneficial uses of the ground water.

The standards are expressed as maximum contaminant levels (MCLs) in DEQ's Ground Water Rule (IDAPA 58.01.17.200).

The mixing zone analysis equation referenced in the decision flow chart is taken from EPA (1981) as mentioned previously. Other mixing zone analysis models may be used if accompanied by appropriate justification and/or documentation.

If predicted impacts from the MZA yield results above MCL, the well/site location is unacceptable. If the predicted impacts from the MZA yield results below MCL, the well/site location is acceptable.

In the event the wastewater land treatment site is an existing one, a CZA is done where time (t) = infinity. Time (t) = infinity since the land application system may have been in operation anywhere up to 15 years and as such, is presumed that ground water impacts may have occurred. This step in the flow chart is showing an existing site that potentially has impacted ground water, as compared to a new or proposed site as discussed above, where there is generally no pre-existing ground water impacts from wastewater land treatment. Also, while a five year lag time is used after initiating use of a new site, this same lag time is not appropriate for an existing site, because of the uncertainty of how far a contamination plume may have moved in the ground water since the existing WLAP operation began.

The well wastewater land treatment site location analysis is more protective for existing sites than for new sites. A capture zone analysis where time (t) = infinity yields a zone where every flow line to the well possible is included. Every flow line should be considered since the conservative assumption is made that predicted down gradient steady-state constituent concentrations have the potential to affect the ground water at the wellhead.

The next question asks whether the well is within the capture zone. If it is not, the well/site location is acceptable, as the well will probably not be drawing from a zone influenced by WLAP land-use practices. If the well is within the capture zone, the next question asks whether the wastewater land treatment site is a municipal site. If so, a CZA is done where t = 5 years. If the wastewater land treatment site is within the five year capture zone, the well/site location is not acceptable for reasons mentioned above.

If the well is not within the five year capture zone, an MZA is done to determine whether predicted impacts from the wastewater land treatment site exceed primary and secondary maximum contaminant levels (MCLs) in DEQ's Ground Water Rule (IDAPA 58.01.17.200) (See Section 6.6.3.3 for additional information on the MZA), and so compromise the potable water supply beneficial use.

In the event predicted impacts from the MZA yield results above MCL, the applicant may provide ground water quality data to demonstrate no exceedance of MCLs at the well. The well/site location is not acceptable if there is no ground water quality data substantiating no impacts above MCL. However, in the event there is existing ground water quality data showing levels below MCL, then the well/location is generally acceptable with possible monitoring conditions. If monitoring data show levels higher than MCL, the well/site location is not acceptable.

Should the predicted impacts not exceed MCLs and there is no ground water quality data (either from site monitoring wells or from the well in question), or there is ground water quality data showing levels below MCL, then the location of the well is acceptable. In the event there is ground water data and it shows impacts above MCL, then the well/site location is not acceptable.

6.6.3.2 Capture Zone Analysis

A capture zone, or zone of contribution as it is sometimes called, is defined as the zone surrounding a pumping well that will supply ground water recharge to the well (EPA 1991). Capture zone analyses are done to see whether the delineated zone where a well draws water overlies the boundaries of a wastewater-land application treatment area. Such a well is subject to potential impacts from this land-use activity. A calculation methodology for determining time of travel boundaries is given below. Also discussed are computer models which perform these calculations, and sources of input parameters for modeling software.

6.6.3.2.1 Determination of Basic I Time of Travel Boundaries

The radii calculations (calculated distances outward from the well representing time of travel boundaries) are based on advective transport and have taken into consideration the velocity of ground water around pumping wells and the velocity of the natural regional ground water flow. The calculated distance is in an upgradient direction from the well and combines these two components.

The derivation of the velocity of ground water flow around pumping wells is an additive process of the average linear velocity equation and the Theis equation for the radial component. The average linear velocity is a velocity representing the rate at which water moves through the interconnected pore spaces. The Theis equation predicts the drawdown in hydraulic head in a confined aquifer at any distance “r” from a well at any time “t” after the start of pumping if the aquifer properties of transmissivity (T), storativity (S), and pumping rate (Q) are known. The Theis equation assumes the hydraulic properties of the aquifer are uniform throughout the area of interest. These two equations are given below.

1) Average linear velocity equation:

$v = (K/n_e)(dh\cancel{s}/dl\cancel{r})$

where,

K = hydraulic conductivity, in gallons per day per ft^2 (gpd/ft^2)

n_e = effective porosity

(dh/dl) = hydraulic gradient through the well in an up gradient direction (change in head, h, over a given distance, l)

2) Theis equation:

$s = (Q/4\pi T) \int e^{-u}/u)du$, where $u = (r^2S/4Tt)$ and $(du/dr) = (2rS/4Tt)$

If the Theis equation is expanded and differentiated with respect to “r” from u to infinity, the factor, (ds/dr), can be substituted into the linear velocity equation to simplify the equation to:

$v = (K/ n_e)(Q/2\pi Tr)\ e^{(r2S/4Tt)}$

where,

Q = flow rate in gallons per day (gpd)

T = transmissivity in gallons per day per ft (gpd/ft)

r = distance between observation point and well in feet

S = storativity

s = drawdown in feet

t = time in days

As the drawdown approaches equilibrium, i.e. when “t” is very large, $e^{(r2S/4Tt)}$ will approximate 1, so the velocity equation can be simplified to:

$v = (K/ n_e)(Q/2\pi Tr)$

The equation used to calculate the radius plus the distance that accounts for regional flow up gradient of the well (including the conversion factor of 1 ft^3/day = 7.48 gal/day) is:

Distance $=(K/(7.48 \text{ x } n_e))(ds/dr) + (K/(7.48 \text{ x } n_e))\ (Q/2\pi Tr)$

6.6.3.2.2 Capture Zone Modeling Software

The Wellhead Protection Area (WHPA) software may be used to define these capture zones, which is a modular semi-analytical model developed by EPA-(1991)

WHPA computes the distance from a wellhead that a particle would need to be in order to arrive at the wellhead in up to ten (10) years. The calculation assumes:

- that the well has been pumping at the specified flow rate for a very long time such that an equilibrium velocity is established;
- a straight line from the point of origin of the parcel and the well; and
- that the groundwater flow is in the direction of the parcel flow.

Calculated radii, utilizing the methodology above, for the various hydrogeologic settings and different pumping rates are given in Tables 4.8a- e in DEQ (1997). The results of the calculations for the 2 year and the 5 year time of travel wellhead protection areas were spot checked with results calculated from the WHPA Code 2.0. The calculations for the 2 year and the 5 year wellhead protection areas are comparable (See DEQ, 1997, Figures F-1 through F-4, which show both numerical results and plot graphs of time of travel boundaries). This software, however, has been superceeded by WhAEM 2000 (EPA, 2000).

6.6.3.2.3 Sources of Input parameters

General input values for capture zone models can be found in DEQ's Idaho Wellhead Protection Plan (DEQ 1997) among other sources. Several important model input sources are appended. Figure 2-1 shows locations and types of major aquifers in Idaho. The appendix contains a general table of aquifer properties, an extended table of transmissivities (and other data) for several wells in Idaho, a table of hydraulic conductivities, a map of hydraulic conductivity zones, and, from Freeze and Cherry (1979) hydraulic conductivities for typical aquifer materials. The latter four provide general parameter values for input to the capture zone model mentioned above. Each site should use values as site specific as possible for input to the model. The appendix also has a series of figures showing example capture zone delineations for major aquifers in Idaho, including mixed volcanic and sedimentary rocks, primary sedimentary rocks, unconsolidated alluvium, Colombia River basalts, and East Snake River Plain basalts.

6.6.3.3 Mixing Zone Analyses Ground Water Impact Limitations from Wastewater-Land Application

The calculations described below provide estimates of potential ground water constituent concentrations resulting from the operation of a WLAP system: 1) after the system has reached steady state conditions; and 2) under ongoing consistent management of the system. These constituent concentrations should not exceed current primary and secondary maximum contaminant levels (MCLs and SMCLs).

One mixing zone analysis equation used to predict steady state ground water quality is found in EPA (1981). It provides a rough estimate of the potential of the site, as managed or as proposed to be managed, to impact ground water moving beneath the site.

The following formula from EPA (1981) may be used:

$$Cmix = \frac{Cp*Qp + Cgw*Qgw}{Qp + Qgw}$$

Where:

Cmix = steady state ground water concentrations down gradient of (after) mixing percolate and ambient ground water. (mass/volume).
Cp = concentration of constituent in percolate(mass/volume).
Qp = flow of percolate (volume/time)
Cgw = ambient upgradient concentration of constituent (mass/volume).
Qgw = flow of ground water (volume/time).

Calculated final ground water concentrations (Cmix), should not exceed maximum contaminant levels. Other appropriate methods may be used. As mentioned in Section 6.6.3.2.3, Figure 2-1,and the appendices provide select aquifer characteristics for input into the equation. The appendix also provides hydraulic conductivity values for various rock types in the eastern Snake River Plain. Site specific values are preferred when possible. It is essential for the user to be familiar with the assumptions of the model to be able to interpret the output. It must be noted that calculations of this sort are a rough estimate, and do not take into account attenuation mechanisms which will certainly take place to varying degrees in the environment. Modifications of these calculations can be made and more sophisticated models used to predict with greater accuracy impacts to the ground water. Other factors that may be considered include: operational period of the facility; decay and degradation; retardation; and adsorption, precipitation and other chemical reactions.

6.6.4 References

EPA, October 1981. Process Design Manual - Land Treatment of Municipal Wastewater, EPA 625/1-81-013.

EPA , March 1991. WHPA: A Modular Semi-Analytical Model for the Delineation of Wellhead Protection Areas - Version 2.0.

EPA, April 2000. Working with WhAEM 2000 – Source Water Assessment for a Glacial Outwash Wellfield, Vincennes, Indiana. Office of Research and Development, Washington D.C. EPA/600/R-00/022.

Freeze, R. A., and J. A. Cherry. 1979. Groundwater. Prentice Hall. 604 p.

Garabedian, S. P., 1989. Hydrology and Digital Simulation of the Regional Aquifer System, East Snake River Plain, Idaho. USGS Open File Report 87237, 140 p.

Idaho Division of Environmental Quality, February 1997. Idaho Wellhead Protection Plan. (DEQ, 1997)

6.7 Site Closure

Permanent site closure of a WLAP site often necessitates a closure plan. The plan should include an environmental assessment of possible adverse impacts resulting from the prior permitted facility and the decommissioning of pumps, storage lagoons and other miscellaneous equipment; the treatment of sludge or wastewater in the lagoons; site restoration; and any necessary corrective actions. Site closure should be discussed as a mutual issue of concern for the WLAP permittee and DEQ. It is critical that the protection of public health and existing and future beneficial uses of the waters of the state are maintained after site closure.

DEQ makes the following recommendations regarding site closure for a wastewater-land application system:

- Site closure should be included as a standard permit condition for each wastewater-land application facility.
- The standard permit condition should include two elements:

(1) Permittee notification of DEQ six months prior to closure or as far in advance of closure as possible; and

(2) A pre-site closure meeting between the permittee and DEQ during which specific closure or clean-up tasks will be identified and time-lines for completion of tasks for both DEQ and the permittee.

- A site closure plan should be developed by the permittee based on the agreements and results of the pre-site closure meeting. The plan should be submitted to DEQ within 45 days after the pre-site closure meeting and finalized with signatory agreement by all parties prior to commencing site closure activities.

In any event, site closure should be included as part of the submittal package for each *new* wastewater land application facility. This same practice is encouraged for each permittee at the time of permit renewal.

6.8 Weed Control at Wastewater Land Treatment Facilities

Weed control is a necessary practice at wastewater land treatment facilities. Facilities should manage their sites to control weeds, including noxious weeds. Procedures to address control of noxious weeds should be included in the facility plan of operation or O&M manual. DEQ should be kept informed of proposed plans to noxious weeds as it may affect the performance of land application sites.

6.8.1 Weed Control – General Considerations

Lagoon areas should be free of weeds. Vegetation surrounding lagoons, if present, should be mowed short. Uncontrolled vegetative growth surrounding lagoons provides habitat for rodents and other undesirable animals which may do damage to the structure of lagoons. Also, such growth may interfere with necessary operation of the lagoons. Weed control is also necessary on wastewater land treatment sites as well. Crops, which beneficially utilize water and nutrients, grow successfully when not in competition with weedy species. It is important for facilities to be aware of Idaho's Noxious Weed Program which is discussed below, to better control weeds and better manage facilities.

6.8.2 Idaho's Noxious Weed Program

The Idaho State Department of Agriculture (ISDA) is responsible for administration of the State Noxious Weed Law. The following website has information regarding noxious weeds found in Idaho, ISDA rules and requirements regarding noxious weeds, county contacts to discuss how to deal with noxious weeds, and other related information.

http://www.agri.state.id.us/animal/weedintro.htm

The frequently asked question~~s~~ (FAQ) section of the Web site provides a general background on noxious weeds in Idaho.

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7. Monitoring

Wastewater Land Application Program (WLAP) monitoring is a comprehensive program that provides information for managing and regulating WLAP sites. WLAP monitoring is determined by site-specific environmental and operational parameters.

This section presents guidance and provides the technical references that should be considered when designing a WLAP monitoring plan and establishing permit conditions for monitoring in a wastewater land application facility. General discussions of monitoring as well as particular discussions of commonly monitored media are also presented.

7.1 General Discussion

Several general considerations apply to all facilities in the wastewater land application permit (WLAP) program administered by DEQ:

- Monitoring Objectives
- Monitoring Parameters
- Monitoring Frequency
- Sampling and Sampling Location Determination
- Analytical Methods
- Quality Assurance and Quality Control
- Data Processing, Verification, Validation, and Reporting

Monitoring recommendations for commonly monitored media are provided in the following to assist in the development of a WLAP monitoring program. Each type of monitoring is discussed in a separate section and the discussion follows the outline of the general section.

Commonly monitored media include the following:

- General discussion (Section 7.1)
- Ground water monitoring (Section 7.2)
- Soil-water monitoring (Section 7.3)
- Soil monitoring (Section 7.4)
- Wastewater monitoring (Section 7.5)
- Crop monitoring and yield estimation (Section 7.6)

7.1.1 Monitoring Objectives

The goal of WLAP monitoring is to provide a timely and cost-effective assessment of both wastewater treatment process operations as well as the impact of operation and management activities on ground water, surface water, soil resources and crop health. Monitoring information provides valuable feedback to determine whether wastewater land treatment changes should be made to manage environmental impacts. All permits need to specify required monitoring sufficient to yield data that are representative of the monitored activity. WLAP monitoring requirements should have well defined objectives – i.e., it should be known how the data will be used. Useful data are generated when the purposes of monitoring are understood.

The three objectives of environmental monitoring are as follows:

a) Site Characterization

It is necessary to characterize baseline conditions of ground water, soil water, surface water, soils, and other media prior to initiation of wastewater land treatment activities and for system design purposes. Characterization of variability in monitored media, particularly wastewater and ground water, is a prerequisite to establishing monitoring schedules.

b) Site Management or Process Control Monitoring

Process control monitoring involves monitoring internal components of both the wastewater land application system and other associated wastewater treatment processes to determine whether they are functioning as designed (Crites et al. 2000). This monitoring can yield information that can be used to modify ineffective management practices.

c) Compliance Monitoring

Compliance monitoring is required in regulatory instruments so that an adequate determination of whether a wastewater-land application system is complying with applicable water quality standards, permit specific limits, and other WLAP permit conditions. Compliance monitoring includes environmental parameters, such as ground water quality. It also includes monitoring of treatment parameters, such as constituent loading, which serve as a first line of monitoring to be protective of the resource (ground water for example)

Consideration of these objectives is necessary to develop a program or strategy with the combination of monitoring that will best fit the needs of a given wastewater-land application site.

A quality assurance project plan should be written as prescribed in Section 7.1.6.

7.1.2 Monitoring Parameters

All parameters with permit limits must have associated monitoring requirements in the permit. Parameters that do not have regulatory-established limits may be included to meet clearly defined monitoring objectives as required by DEQ. Media-specific monitoring parameters are discussed in respective sections below. As will be discussed further, choice of parameters to monitor is facility-specific. Not all parameters are necessary for every site.

7.1.3 Monitoring Frequency

The frequency of sampling should result in the generation of data that provide a reasonable characterization of the media. Reasonableness can be demonstrated on the basis of the value of data collected versus cost. A primary value of the data is the establishment of data variability, an important factor in calculating permit limits, determining compliance and establishing the basis for monitoring frequency. Routine compliance monitoring frequency may be adjusted to reflect the variability - less variable parameters being sampled less frequently, while more highly variable parameters are sampled more often. The intent is to establish a frequency of monitoring that will detect most events of noncompliance without requiring needless or burdensome monitoring and associated costs.

7.1.3.1 Temporal or Spatial Variability

Variability can be temporal or spatial:

- Soils can have significant spatial variability. Monitoring considerations related to soil spatial variability are discussed in 7.4.5.2 *Sampling Location Determination*, page 7-47.
- Temporal variability of the media being monitored is one of the most important factors in establishing monitoring frequency. Therefore, the degree of monitoring frequency is dependent on the characterization of temporal variability. Various sampled media exhibit different variability. Particular parameters measured from one sampled medium can also exhibit different variability. An example of the variability over time of potato processing wastewater COD levels for one year is shown in Figure 7-1.

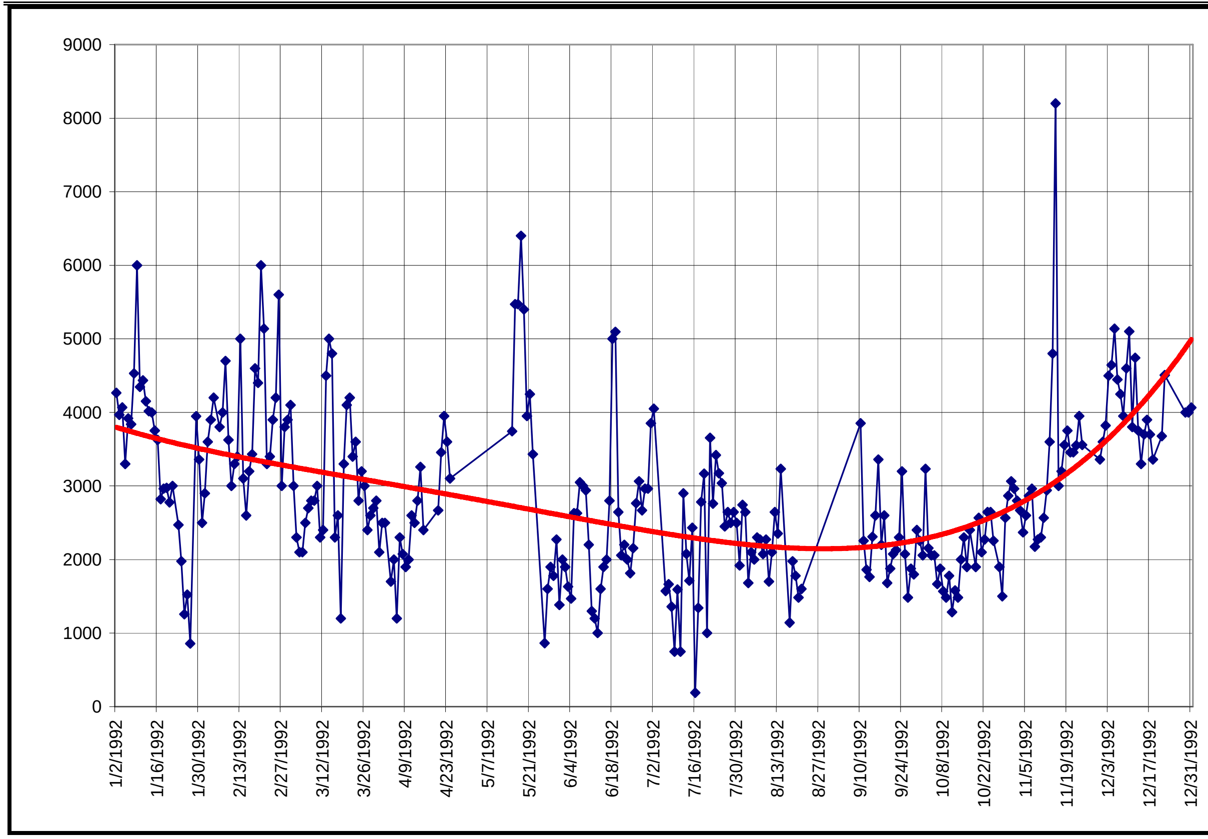

Figure 7-1. Potato processing wastewater COD levels for one year.

- Characterization of medium and parameter variability should be included as a part of the permit application (see Section 1). High frequency monitoring, usually within a tiered framework or as a special study, is recommended to characterize temporal variability of a medium. The frequencies for monitoring may be determined based on the estimated variability.

There are various statistical approaches to determining variability and sampling frequency. DEQ has developed a spreadsheet tool and explanatory text, which provides one such method for use in wastewater land treatment facility permitting. (See *Program Forms and Spreadsheets* in the appendix.)

7.1.3.2 Tiered Monitoring

Tiered Monitoring is a term used to describe a reduction or increase in frequency of monitoring required in a permit. If initial (baseline) sampling shows little variability in a parameter, a reduced monitoring scheme may then apply. Likewise, if initial (baseline) sampling indicates strong variability in a parameter, a more frequent and/or more comprehensive monitoring schedule would apply. Tiered monitoring decisions are based on the results of previous monitoring. The conditions for increase and decrease should be specified in the permit.

The triggers for the tiered elements of a permit should, where possible, be well defined in the permit and explained in the staff analysis. The permit should explain to what frequency the tiered parameter will revert if not detected, not found to be at a level of concern (a trigger), or exceeding a level of concern. The numeric level of concern or other trigger should be defined in the permit and justified in the staff analysis. The reduction, elimination, or increase in monitoring should also be contingent upon formal notification from DEQ to the permittee of the monitoring change, be that a permit modification or written notification. Monitoring changes should be discussed with the permittee prior to formal notification.

7.1.4 Sampling and Sample Location Determination

Monitoring requirements in the permit should specify the sample type (grab, composite or continuous), and the analytical methods for each parameter. Sampling, sample handling, and analytical methods should conform to the guidance provided here and in the technical references cited.

7.1.4.1 Sampling

The sample type will depend on the following:

- The parameter to be monitored. To determine appropriate sample types, consult references provided for each respective media.
- The temporal and spatial variability of the media sampled.
- The type of regulatory limit that may be applied to sample results.

7.1.4.1.1 Discrete Grab or Sequential Grab Samples

A *grab sample* is an individual sample that represents "instantaneous" conditions. Use grab samples when the following is true:

- The characteristics of the media sampled are relatively constant
- The parameters to be analyzed are likely to change with storage
- The parameters to be analyzed are likely to be affected by compositing
- Information on variability over a short time period is desired
- Composite sampling is impractical, or the compositing process is liable to introduce artifacts of sampling
- The spatial parameter variability is to be determined

Another type of grab sample is sequential sampling, which is discussed in 7.5.5.1.1 Discrete Grab or Sequential Grab Samples, page 7-58.

7.1.4.1.2 Composite Samples

A *composite sample* consists of a series of individual samples collected over time and analyzed as one sample. Application of composite sampling to various monitored media is described in the respective media sections.

7.1.4.1.3 Continuous Monitoring

Continuous monitoring is another option for certain parameters and media, such as wastewater flow, pH, salinity and temperature; climate parameters; and soil moisture content. Important factors to remember about continuous monitoring include the following:

- Continuous monitoring is appropriate for a limited number of parameters.
- Reliability, accuracy and cost vary with the parameter.
- Continuous monitoring can be expensive, so the environmental significance of the variation of parameters of a given media should be compared to the cost of continuous monitoring equipment available.
- Continuous monitoring provides a considerable amount of data and its use should be clearly defined.

7.1.4.1.4 Other Sample Types

Several other types of samples can also be taken:

- *Split Sample* - A split sample is portioned into two or more containers from a single container. Portioning assumes adequate mixing to assure the split samples are, for all practical purposes, identical.
- *Duplicate Sample* - Duplicate samples are collected sequentially from the same source, under identical conditions, but into separate containers.
- *Control Sample* - A control sample is collected upstream, up-gradient, or away from the influence of a source or site to isolate the effects of the source or site on the particular medium being evaluated.
- *Background Sample* - A background sample is collected from an area, water body, or site similar to the one being studied but located in an area known or thought to be uninfluenced by site activities being regulated .
- *Sample Aliquot* - A sample aliquot is a portion of a sample that is representative of the entire sample.

7.1.4.2 Sampling Location Determination

The point at which a sample is collected can make a large difference in the monitoring results. The purpose of monitoring is to observe changes in conditions and compare them to expected or desired outcomes. For this reason, permanent sampling locations should be determined and identified in permit monitoring requirements. Monitoring data can then be compared without concern for spatial variability introduced under conditions where sampling locations are not permanent. The permit applicant should provide a description of all proposed monitoring locations in application materials. Important factors to consider in selecting the sampling station include the following:

- The volume of media at the sampling station should be adequate in order to obtain a sample.

- The sampling station should be easily and safely accessible.
- The sample should be truly representative of the media during the period monitored.

Additional sampling information is given in the *Handbook for Sampling and Sample Preservation of Water and Wastewater* (EPA, 1982):

http://yosemite.epa.gov/water/owrccatalog.nsf/e673c95b11602f2385256ae1007279fe/fe398acacbde5cf685256fc1004e5680?OpenDocument&CartID=9992-112918

7.1.5 Analytical Methods

Approved analytical methods for parameters usually include sampling and handling requirements. Media specific analytical methods are found in respective sub-sections of this section. Recommended analytical methods, in addition to information regarding sample preservation and handling, are also found in the *Ground Water and Soils Quality Assurance Project Plan Development Manual* (DEQ, 2001):

http://www.deq.state.id.us/water/data_reports/ground_water/contaminants_detected_statewide_monitoring_program.pdf

Standardization of analytical methods is important in the WLAP program, so that data can be consistently interpreted with respect to site performance and compliance with standards and/or permit-stipulated limits. Different analytical methods can yield different results: for example, a soil analysis for plant available phosphorus (P) might yield a result of 15 mg P/kg soil, while an analysis for total phosphorus (most of which is not plant available) may yield a result around 650 mg P/kg soil (Overcash and Pal, 1982; page 394). In addition, plant available phosphorus has useful agronomic interpretive value while total phosphorus does not.

Laboratory analyses have low fundamental detection limits, method detection limits (MDLs) and practical quantitation limits (PQLs):

- MDLs are the minimum concentrations that a laboratory method can measure above the instrument background noise. MDLs indicate only the minimum detection level of an analyte but do not imply any accuracy or precision in the result. As such, MDLs have little reporting value but rather reflect the standard basic capabilities of a laboratory for specified testing methods.
- PQLs are the minimum concentrations that can be reported within specified accuracy or precision criteria. PQLs can be affected by analyst skill, interferences in the sample and other operating factors. Where MDLs are typically consistent, PQLs typically vary. PQLs are always higher than MDLs, and they should be used for reporting and interpretation.

PQLs reported at or above concentrations of interest (regulatory limit, previously established lower background level, etc.) render the data useless.

For example, if the PQL for manganese (Mn) provided by a laboratory is at the ground water standard (previously the maximum contaminant level, or MCL) of 0.05 mg/L for a ground water sample, the data have no interpretive value for the entire range below the ground water standard. A method having a MDL of 0.005 mg/L, for example, would be appropriate so long as sampling protocol minimizes interferences (e.g. minimizing turbidity in ground water samples) such that the PQL is achievable.

The tables in respective sections below provide~~s~~ guidance regarding chemical analytical methods recommended for environmental monitoring required in WLAP permits, including ground water, soil water, soils, wastewater, and plant tissue analyses.

Standard operating procedures regarding sample collection, preservation, storage, transportation, and preparation of samples, are also important to assure sample integrity. Recommended procedures are outlined in *EPA (Revised 1979 and March 1983), Greenberg et al (1992),* and other relevant texts.

7.1.6 Quality Assurance and Quality Control

Data gathered in WLAP monitoring programs provides information to decision makers on the quality of ground water, soils, wastewater, leachate, etc. data collected, the adequacy of operation and maintenance procedures, and the potential for land application activities to affect the environment. If decision makers are to have confidence in the quality of environmental data used to support their decisions, there must be a structured process for quality in place. A *Quality Assurance Project Plan* (QAPP) is the environmental industry standard for a structured process for quality in the collection of environmental data.

The QAPP is the single most important quality assurance tool at the project or monitoring program level, and is necessary for all data collection and generation activities. The QAPP summarizes the DQOs (Data Quality Objectives) of the project or monitoring program and integrates technical and quality aspects, including planning, implementation, and assessment into a single document.

The purpose of the QAPP is to document planning efforts for environmental data collection, analyses, and data reporting to provide a project-specific “blueprint” for obtaining the type and quality of data needed for a specific decision or use. The QAPP documents the activities that will take place during the project or monitoring program, including: field and laboratory activities; data verification and validation; data storage and retrieval; data assessment; and, project or monitoring program evaluation and process improvement. The QAPP documents how QA (quality assurance) and QC (quality control) are applied to environmental data collection activities to assure that the results obtained are of the type and quality needed and expected. QA is defined as: “An integrated system of management activities involving planning, implementation, documentation, assessment, reporting, and quality improvement to ensure that a process, item, or service is of the type and quality needed and expected by the client.” (EPA QA/R-5, March 2001). QC is defined as: “The overall system of technical activities that measures the attributes and performance of a process, item, or service against defined standards to verify that they meet the stated requirements established by the customer; operational techniques and activities that are used to fulfill requirements for quality.” (EPA QA/R-5, March 2001).

The success of an environmental monitoring program depends on the quality of the environmental data collected and used in decision making, and this may depend significantly on the adequacy of the QAPP and its effective implementation. Data users, data producers, and decision makers should be involved in the QAPP development process for their monitoring program to ensure that their needs are adequately defined and addressed in the QAPP.

7.1.6.1 QAPP Development and Submittal Guidance

The permittee's QAPP should be developed to comply with EPA QA/R-5 *Requirements for Quality Assurance Project Plans* EPA/240/B-01/003, March 2001. QA/R-5 allows flexibility in the degree of rigor to be applied via the QAPP depending on the type of environmental monitoring to be performed, the intended use of the data, and the risk involved in using data of uncertain quality. Section 7.7.2 lists the content elements that should be addressed and included in a QAPP according to QA/R-5. The permittee's QAPP for a monitoring program should be submitted by the permit applicant as part of the application material for review and approval by DEQ.

7.1.6.2 Quality Control (Q/C) Samples for Monitoring

QC procedures should be described in the QAPP as they relate to the use or taking of QC samples during data collection activities. Field duplicate samples should be taken at a minimum rate of 5% (one duplicate for each 20 samples collected) or one duplicate per sampling event, whichever is less, to provide for determining field sampling precision. A field or equipment blank (rinsate blank) should be taken, one for each sample delivery group. Rinsate blanks shall be analyzed to determine if in-field equipment decontamination procedures are adequate. Trip blanks should be taken if there is reason to believe that a possibility of cross contamination may exist. Trip blanks provide a means to check sample collection, handling, and shipping methods to determine if cross contamination is occurring during those activities.

Laboratory QC samples should also be addressed in the QAPP and should be as specified in the applicable analytical method.

7.1.7 Data Processing, Verification, Validation, and Reporting

Data processing, data verification, and data validation are quality assurance tools used to determine if data has been collected as specified in the QAPP with respect to compliance, correctness, consistency, and completeness. In addition, these tools are used to assess the technical usability of the data with respect to the planned objectives or intention of the project or monitoring program. Although these tools are really processes, project or monitoring program specific measurement criteria for the data processing, verification, and validation should be determined during project or monitoring program planning and documented in the QAPP.

Data Processing includes data entry, validation, transfer, and storage. The QAPP should describe or reference specific procedures used to maintain the integrity of the data records as well as any project or monitoring program specific data storage/transmittal requirements. This process includes data formats and standards for the transfer of data to external data users. Specific data processing activities may include:

- Collection: For both manual data and computerized data acquisition systems, internal QC checks should be developed and implemented to avoid errors in the data collection process.

- Transfer: Data transfer steps should be minimized and procedures established to ensure that the data is free from errors and is not lost during transfer.
- Storage: At each stage of data processing, procedures should be established to ensure that data integrity and security are maintained. The QAPP should indicate how specified types of data will be stored with respect to format, media, conditions, location, retention time, and access.
- Reduction: Data reduction includes any process that changes either the form of expression, the numerical value of data results, or the quantity of data. This includes verification, validation, and statistical or mathematical analysis of the data. Reduction is distinct from data transfer in that it entails a change in the dimensionality of the data set. Procedures for verifying the validity of the reduction process should be described in the QAPP.

Data Verification refers to the process of evaluating the completeness, correctness, and conformance/compliance of a specific data set against the method, procedural, or permit requirements. It focuses on determining that the data have met the measurement requirements. Verification evaluates the data for basic elements such as sampling the correct sites, sample handling, chain-of-custody procedures were followed, QAPP specified analytical methods were used, the appropriate parameters were analyzed, etc. Data verification is not concerned with evaluating or assessing the quality of the data set.

Data Validation is an analyte and sample specific process that extends the evaluation of data beyond method, procedural, or permit compliance (i.e., data verification) to determine the analytical quality of a specific data set. Data validation criteria are based on the data quality objectives or measurement quality objectives specified in the QAPP.

Additional information and specific guidance and procedures for data verification and data validation can be found in the following EPA documents:

- Guidance on Environmental Data Verification and Data Validation (EPA QA/G-8 EPA/240/R-02/004, November 2002)
- EPA Contract Laboratory Program National Functional Guidelines for Organic Data Review (EPA540/R-99/008 October 1999)
- EPA Contract Laboratory Program National Functional Guidelines for inorganic Data Review (EPA540/R-01/008 July 2002)

The first document above, and other EPA quality assurance requirements and guidance documents can be found at this EPA web site:

http://www.epa.gov/quality/qa_docs.html

The second and third documents above can be found at this EPA web site:

http://www.epa.gov/oerrpage/superfund/programs/clp/guidance.htm

Data Reporting requires that operational, wastewater quality and ground water quality records be maintained. Permits require that this information be reported to the DEQ State Office and to the appropriate DEQ Regional Office. The reporting frequency may be monthly, annual, or may correspond either to the frequency with which the information is collected or as required in the WLAP permit. Permits generally require that all monitoring data collected for required parameters be reported, even if collected at frequencies above that required in the permit. This requirement is meant to help guard against the potential of reporting bias if only certain results out of a greater pool of results are reported. If parameters other than those required in the permit are monitored, these results are not required to be reported.

It is critical that data be given to DEQ in a format suitable for the data's intended use. In all cases, the data must be presented in an organized and clear manner, and if necessary, supporting data may be required (e.g., duplicate measures, spike recoveries, etc.). The data collected as required in the permit should be submitted to DEQ in the *Annual Report* in a standardized electronic Excel spreadsheet format. This spreadsheet and accompanying instructions may be obtained from DEQ by request; they are generally provided during the permit application, issuance and renewal process.

The Annual Report is submitted to DEQ on a regular schedule stated in the permit. Special reports may be required in a permit, which frequency and format should be specified in the permit.

The monitoring data required in the permit is taken from the annual report and entered into a computerized database. This database is called the WLAP Information Management System (WLAP-IMS). The WLAP-IMS, when fully developed, will be able to generate compliance reports as well as data analyses of ground water, soils, soil water, loading rates, wastewater chemistry, trend analyses etc.

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7.2 Ground Water Monitoring

This section describes the elements of a ground water monitoring plan for wastewater land treatment facilities. (It is beyond the scope of this section to address monitoring of sites having hazardous or radionuclide constituents.)

Ground water monitoring provides data that can be used to evaluate a facility's impact on ground water as well as evaluate ground water quality changes with respect to changes in wastewater land treatment management and loading changes. Ground water monitoring also serves to assess compliance with a wastewater land application permit, including ground water quality standards as specified in the *Ground Water Quality Rule* (IDAPA 58.01.11.200) and/or permit specific limits. Ground water monitoring is necessary in most circumstances to define ambient conditions and establish a water quality baseline for the facility. Ground water monitoring often plays a major role in evaluating and modifying treatment processes, management, and loading practices to protect and maintain ground water quality.

The need and level of ground water monitoring is dependent upon facility type and size, wastewater characteristics, management, loading rates, and aquifer and site characteristics. For example, a small facility with low strength wastewater loaded at low rates would have a limited potential to contaminate ground water and may not need as extensive a monitoring program as larger and more complex facilities land applying high strength wastewater at high rates.

7.2.1 Alternatives to Ground Water Monitoring

There are circumstances where ground water monitoring may not be necessary, as in the case where wastewater constituent loading rates are *below levels of regulatory concern* (i.e., *de minimus* rates).

Although monitoring wells are the primary means of assessing ground water quality associated with land treatment systems, there are situations where their use would be impractical, such as in cases where there are long unsaturated and or saturated contaminant travel times (as a result of deep ground water, low percolate generation, and/or low permeability of vadose zone). In those cases, the time interval between land use activities and environmental response would be too large to provide timely feedback for management or compliance purposes.

Short, moderate, and long travel times are subjective, depending on the context. In a regulatory context, a long travel time might be considered to be the length of a typical 5-year permit. It could be considered *untimely* if the impacts from a management activity could not be detected through ground water monitoring beyond the life of the permit.

Other means to assess potential environmental impacts, such as soil-water monitoring, should be considered in such cases. (See Section 7.3 for additional discussion on soil-water monitoring. A simple method of estimating travel time through the vadose zone is presented by 7.7.5.2.3.)

Alternatives to ground water monitoring are considered on a case-by-case basis. A decision flowchart 7.7.1.1) serves to help determine whether ground water monitoring is practical and/or needed at a wastewater land treatment site. In general, 'de minimus loading rates' referred to in the flowchart are loading rates, which pose no regulatory concern. Specific numerical loading rates have yet to be defined and may be facility specific. The reference to *Guideline Loading Rates* refers to those generally recommended loading rates (nutrients, COD, hydraulic etc.) found in Section 4 of this guidance.

7.2.2 Monitoring Objectives

The purpose of ground water monitoring is to determine whether wastewater is being land applied and treated such that the waters of the state are protected for existing and projected future beneficial uses. Monitoring wells are preferred over other types of wells for collection of ground water quality samples. They can be located in a specific location and they can be constructed to monitor specific zones within an aquifer to isolate particular contaminants. Monitoring wells are installed specifically for assessing ground water quality.

Existing wells may be used for ground water monitoring only if the well is properly located, constructed and it is screened in the appropriate interval necessary to monitor the appropriate aquifer and the constituents of concern. Existing wells should be evaluated using the criteria provided below. Exceptions to these criteria may be made by DEQ on a case-by-case basis:

- The well is located within a reasonable distance from the wastewater land treatment facility to provide relevant ground water quality information.
- The well meets the construction requirements outlined in IDAPA 37.03.09.
- The well is completed in the uppermost aquifer.
- The screen length is appropriate for the hydrogeologic conditions and monitoring the constituents of concern.
- The well will yield water quality samples representative of background or other relevant water quality conditions.
- The water quality is not degraded by an activity between the well and the wastewater land application facility.

- The well is approved for use by DEQ.

7.2.3 Monitoring Instrumentation

This section provides guidance on monitoring well design and construction practices for wastewater land application facilities. This monitoring well construction guidance is not applicable for sites where hazardous materials are known to exist.

Monitoring wells should be designed to sample the uppermost ground water potentially affected by the activity plus any other ground water zone where contaminants may impact ground water quality. The number of wells installed should be sufficient to adequately assess background water quality and the impacts to ground water as a result of wastewater land treatment activities. Monitoring well construction is a critical component of the monitoring plan since background water quality data are used to establish baseline levels, and possibly site specific permit limits and early warning values. Each monitoring well should be designed and constructed for the specific hydrogeologic environment and the contaminants of concern.

Several goals should be achieved in monitoring well construction:

- Construct the well with minimal disturbance to the formation.
- Use materials compatible with the geochemical environment.
- Complete the well within the zone of interest.
- Adequately seal the borehole with materials that will not influence the quality of the samples.
- Sufficiently develop the well to remove additives introduced during drilling and allow unobstructed flow through the well, (EPA, 1991b).
- Construct the well in such a manner that contamination from the surface will not migrate along the sides of the borehole and ensure that well is sealed properly to prevent cross contamination from other aquifers

Some general guidelines should be considered during the construction of any monitoring well. The most important of these address the following:

- regulatory requirements
- drilling methods
- screened interval
- casing materials
- seals, packing and grouting
- well development

7.2.3.1 Regulatory Requirements

All monitoring well construction must conform to the well construction rules listed in the Idaho *Administrative Procedures Act* (IDAPA) 37.03.09. Monitoring wells more than 18 feet in vertical depth that are constructed to evaluate, observe or determine the quality, quantity, temperature, pressure or other characteristics of the ground water or aquifer require a permit to be issued by the *Idaho Department of Water Resources* (IDWR). Monitoring wells 18 feet deep, or less, also should conform to the well construction rules listed in IDAPA 37.03.09

Siting of monitoring wells in relation to a wastewater land treatment site and other possible sources of contamination should be coordinated with DEQ as part of the WLAP permitting process. Proposed monitoring well designs should be submitted to DEQ for review and approval prior to well construction.

Certification that monitoring well construction is in substantial accordance with proposed monitoring well design should be submitted to DEQ. Such certification may consist of as-built diagrams stamped by an Idaho registered Professional Geologist or Professional Engineer, or prepared by someone under the direct supervision of an Idaho registered Professional Geologist or Professional Engineer. A detailed geologic log for each monitoring well should also be provided to DEQ.

7.2.3.2 Monitoring Well Construction

Specific installation procedures for ground water monitoring wells may be found in the Idaho Administrative Code, Department of Water Resources, *Well Construction Standards Rules* (JAC 2005); Ogden (1987); DEQ (March 2001); EPA (1991b); and EPA (1986a). Additional guidance is available from ASTM D 5092-90.

Details regarding the construction of monitoring wells are found in 7.7.3.1. Included in this appendix are discussions of drilling methods; selection of screened interval depths; casing materials; seals, packing and grouting; and monitoring well development.

7.2.3.3 Monitoring Well Protection and Maintenance

The area around groundwater monitoring wells must be protected. Several practices may be employed for this. Highly visible markers may be used to warn equipment operators of the presence of the well. Using posts cemented into the ground to surround the well offers added protection against a well being damaged by equipment.

Damage from equipment includes cracked grouting, cracked or broken well piping, or broken locks or casings. This type of damage can result in the intrusion of surface water into the well and the contamination of groundwater. Such a well may have to be abandoned and another well constructed, at additional time, expense, and loss of data continuity.

Monitoring wells should be regularly maintained. Maintenance should include ensuring that caps are rust-free and locked at all times, that the outer casing is upright and undamaged, and that there is clear, unobstructed access to each well.

7.2.4 Monitoring Parameters

Table 7-1 provides general guidance for ground water monitoring analytical parameters for selected wastewater land treatment scenarios. In general, well below guideline loading rates (WBGLR) , referred to in the table, are loading rates that pose no regulatory concern. Specific numerical loading rates have yet to be defined for the WBGLR designation and may be facility specific. The reference to *Guideline Loading Rates* refers to those generally recommended loading rates (nutrients, COD, hydraulic etc.) found in Section 4 of this document. Microbiological parameters may be needed on a site-by-site basis.

Table 7-1. Common Ground Water Monitoring Analytical Parameters for Wastewater Land Treatment Facilities.

Facility Type — Analytical Parameter	Municipal Facility (Class A Reuse Water)	Municipal Facility (Guideline Loading Rates)	Municipal Facility (Greater than Guideline Loading Rates)	Facility (Well Below Guideline Loading Rates)	Food Processing Facility (Guideline Loading Rates)	Food Processing Facility (Greater than Guideline Loading Rates)
Common Ions[1]	O[3]	O	X	O	X	X
Field Parameters[2]	O	X	X	O	X	X
Static Water Level	O	X	X	O	X	X
NO3-N + NO2-N	O	X	X	O	X	X
Fe	O	O	?	O	?	X
Mn	O	O	?	O	?	X
TDS	O	O	X	O	X	X
COD	O	O	O	O	?	X
P	O	O	?	O	?	X
K	O	O	O	O	?	X
Cl	O	X	X	O	X	X
TC	O	?	?	O	?	?

Notes:

1. Common ions consist of the following ions: Na, K, Ca, Mg, SO_4, Cl, CO_3, HCO_3
2. Field Parameters consist of the following: pH, temperature, electrical conductivity, and dissolved oxygen
3. Symbol Definitions: X = usually monitored; ? = monitored depending upon case specific situation; O = generally not monitored.
4. TC = total coliform

7.2.4.1 Contaminants of Concern: Nitrate, Iron, Manganese, TDS and Phosphorus

Wastewater sites, if not properly loaded and managed, may impact ground water. Typical contaminants of concern include nitrate, total dissolved solids, phosphorus, metals (iron and manganese in particular). The following sections briefly discuss these constituents.

7.2.4.1.1 Nitrate

Nitrate is a primary ground water constituent, meaning there can be health related concerns at ground water levels above ground water standards (IDAPA 58.01.11.200.01a). The ground water standard for nitrate-nitrogen is 10 mg/L. Nitrate contamination at wastewater land treatment sites usually results from nitrogen overloading. Other contributing factors include aquifers with low transmissivity that do not provide the dilution volume, and so magnify the nitrogen (or other constituent) inputs from percolate.

High nitrogen loading of certain wastewaters such can often result in *low* nitrate levels in ground water. This is due to the influence of associated high loadings of chemical oxygen demanding (COD) constituents – generally organic materials. High COD loadings depress the redox state of the soil and reduce nitrate to atmospheric nitrogen or other nitrogen oxides which are lost to the atmosphere. See Section 4 for further discussion of nitrogen chemistry in the environment. Health risks associated with excessive nitrate ingestion include blue baby syndrome (methemoglobinemia) and are discussed at the following DEQ website:

http://www.deq.state.id.us/water/prog_issues/ground_water/nitrate.cfm

7.2.4.1.2 Total dissolved solids (TDS)

TDS is a secondary ground water constituent, meaning there can be aesthetic related concerns at ground water levels above ground water standards (IDAPA 58.01.11.200.01b). The ground water standard for TDS is 500 mg/L. TDS is a general term that has different interpretations depending on the media it is measured. In ground water, TDS is generally consists of inorganic salts. In wastewaters, TDS can include significant amounts of dissolved organic material. The organic TDS fraction is higher in wastewaters having higher organic constituent levels. When modeling impacts of TDS loading to ground water, it is critical to make some other measure of the inorganic constituents in wastewater to accurately assess the inorganic fraction of TDS. Such measurements include non-volatile dissolved solids (TDS less volatile dissolved solids) or total inorganic dissolved solids (TDIS, the sum of cations and anions in appreciable concentrations). Fixed dissolved solids (FDS) is another analysis which yields the inorganic content of wastewaters (Brown and Caldwell et al., 2002 p. 10-10)

TDS can often be significantly elevated down gradient of wastewater land treatment sites, especially industrial sites. Care must be taken in the interpretation of data to account for other sources of contamination as well. An effective geochemical analysis technique involves the examination of common ions, discussed in Section 7.1.4.3, to characterize chemical signatures of background, and percolate and wastewater sources to determine causes of ground water contamination.

7.2.4.1.3 Phosphorus

Phosphorus has no numeric ground water standard (IDAPA 58.01.11.200). Phosphorus loading and monitoring guidance is described in Section 4. It is a relatively immobile constituent. Concentrations in soil water and ground water are governed by complex chemistry involving sorbed, fixed (covalently bonded), precipitated, organic, and plant available pools. Elevated phosphorus in down gradient ground water can signal breakthrough of wastewater through coarse vadose material – possibly from excessive lagoon seepage or breakthrough from soils that have been loaded to capacity. This is discussed further in Section 4.

7.2.4.1.4 Metals (General)

The ground water quality standards as specified in the *Ground Water Quality Rule* (IDAPA 58.01.11.200.01ci) and the drinking water standards as specified in the Idaho *Rules for Public Drinking Water Systems* (IDAPA 58.01.08.50.01) establish criteria for total metals. Total metals analyses are used to provide an indication of the metals concentration which is available for human consumption. Drinking water wells are designed to maximize water production and minimize sediment intake whereas monitoring wells are designed to monitor changes in ground water quality. Monitoring wells are not designed to produce water for human consumption. The screened interval may not be placed in the most productive part of the formation, rather it is placed in the zone where contaminants are expected to be present which may be in a formation with finer grained sediment.

Total metals analysis measures both the metals dissolved in ground water, and metals which may be sorbed to clay or colloid sized particles suspended in ground water. Upon acidification of a ground water sample for preservation, sorbed or otherwise non-dissolved metals may solubilize. The suspended fraction may be a result of metals from the well casing (metal casing material is not approved for monitoring wells), from collected sediment within the well, or sediment from the formation. A total metals analyses may yield much higher values when wells are place in low hydraulic conductivity formations or when well development has not been properly completed. Dissolved analyses are generally more useful in evaluating the impacts of a wastewater land treatment on ground water quality, since it considers only the fraction, which are not from anthropogenic sources.

The question arises whether metals in ground water should be evaluated using the total or the dissolved fraction. On one hand, only dissolved metals truly migrate in ground water and therefore measuring total metals skews the analytical result by including metals which are adsorbed onto particles of sediment which may only be present in the well due to poor well construction or from a silty formation. On the other hand, total metals not only represent drinking water criteria, but that metals may also move by colloidal transport in ground water, thereby making the total fraction necessary to completely characterize ground water contamination.

If metals are identified as constituents of concern, it is recommended that both total and dissolved metals be analyzed. Dissolved metals should be used to interpret geochemical changes in ground water in relation to wastewater land treatment activities. Water samples analyzed for the dissolved fraction of metals should be filtered in the field, using a filter with a pore size of 0.45 microns and preserved with nitric acid prior to submission to the laboratory.

Another alternative is to measure total metals while using *low flow purge and sampling techniques* recommended by Puls and Powell, (1992). These techniques provide a characterization of both the dissolved fraction and the portion which moves by colloidal transport in ground water. Low flow pump rates allow water from the ground water formation to move into the well while overlying stagnant zones are undisturbed. In order to minimize sample disturbance during collection, a low flow rate of 0.2 to 0.3 liters/minute (not using a bailer) should be used for ground water samples collected for metals analysis with no filtration. Puls and Powell (1992) demonstrated no significant difference in metal concentrations between filtered and unfiltered samples when low flow rates were used. This provides an assessment of both the dissolved and mobile particulates associated with metals transport in ground water.

7.2.4.1.5 Metals (Iron and Manganese)

Iron (Fe) and manganese (Mn) are secondary ground water constituents, meaning there can be aesthetic related concerns at ground water levels above ground water standards (IDAPA 58.01.11.200.01b). The ground water standards for iron and manganese are 0.3 mg/L and 0.05 mg/L respectively. Iron and manganese are often found in ground water down gradient of highly loaded wastewater land treatment facilities. Associated high COD loadings and depressed redox conditions generated in the soil can reduce the valence state of iron and manganese naturally present in soils to soluble forms (see Figure 7-2.) These reduced species are mobile and can leach to ground water. Maximum contaminant levels for iron and manganese are relatively low, being 0.3 mg/L and 0.05 mg/L respectively. See Section 7.1.3.3 for further discussion. Elevated levels of iron and manganese cause aesthetic damage such as staining of kitchen and bathroom fixtures, siding and brickwork of dwellings, and other related damage.

REACTION	Eh AT pH 7 (V)	MEASURED REDOX POTENTIAL IN SOILS (V)
O_2 Disappearance		
$\frac{1}{2} O_2 + 2e^- + 2H^+ = H_2O$	0.82	0.6 to 0.4
NO_3^- Disappearance		
$NO_3^- + 2e^- + 2H^+ = NO_2^- + H_2O$	0.54	0.5 to 0.2
Mn^{2+} Formation		
$MnO_2 + 2e^- + 4H^+ = Mn^{2+} + 2H_2O$	0.4	0.4 to 0.2
Fe^{2+} Formation		
$FeOOH + e^- + 3H^+ = Fe^{2+} + 2H_2O$	0.17	0.3 to 0.1
HS^- Formation		
$SO_4^{2-} + 9H^+ + 8e^- = HS^- + 4H_2O$	−0.16	0 to −0.15
H_2 Formation		
$H^+ + e^- = \frac{1}{2} H_2$	−0.41	−0.15 to − 0.22
CH_4 Formation (example of fermentation)		
$(CH_2O)_n = n/2\ CO_2 + n/2\ CH_4$	—	−0.15 to − 0.22

Figure 7-2. Redox potential and its effect on the chemistry of soil constituents. Bohn et al. 1979.

7.2.4.2 Other Constituents

There are constituents that do not have ground water standard criteria in IDAPA 58.01.11.200, but which are nonetheless important to monitor in ground water. Certain of this constituents, such as COD and potassium, can serve to corroborate (i.e. support with additional evidence) the cause of constituent of concern impacts from certain wastewater land treatment practices. Other constituents serve to characterize the chemical signature of ground waters or indicate the chemical stability of the sample during the sampling event.

7.2.4.2.1 Chemical Oxygen Demand (COD)

It is typical to see COD at low levels in ground water. Sulfides and other reduced constituents will appear as an oxygen demand. COD can appear at elevated levels in down gradient ground water – usually at wastewater land treatment facilities with high COD and hydraulic loading. This serves to corroborate that COD loadings are at rates higher than the soil can filter and soil microorganisms can oxidize. It also can indicate breakthrough of wastewater to ground water, as in an excessively leaking storage structure.

7.2.4.2.2 Potassium

As with COD, potassium does not have a ground water standard, but its presence at elevated levels down gradient of potato processing facilities can indicate impacts from wastewater land treatment. For example, there are appreciable levels of potassium in potatoes. Potassium is released to wastewater upon processing of the potato and is subsequently land applied. Usually there are no other significant sources of potassium to account for the elevated levels seen down gradient. Thus, it is a corroborating constituent.

7.2.4.2.3 Major Cations and Anions

The chemical characterization of ground water quality is important when making a determination of the impacts a wastewater land treatment may have on background water quality. Ground water typically has naturally occurring concentrations of major cations and anions. Major cations and anions may not necessarily be considered constituents of concern, but data collected before and during the operation of the facility can be compared to help assess environmental impacts, (Pennino, 1988).

Major cations and anions for which analyses are typically done are shown in Table 7-2.

Table 7-2. Cations and anions for which analyses typically done.

Cations	Anions
Calcium	Bicarbonate
Magnesium	Carbonate
Potassium	Chloride
Sodium	Sulfate

Natural ground water has a distinct chemical composition, which is characteristic of the geologic formation. Minerals are dissolved in solution as they migrate through the geologic formation. Major ions can be illustrated by using graphical tools such as Stiff Diagrams or Trilinear Plots to characterize the signature of the ground water. Chemical characterization also serves in identifying cross flow between aquifers and mixing within wells. Ionic characterization data can be used to detect water quality changes and trends which may be attributed to the influence of a wastewater land treatment activity.

Common inorganic constituents can be found at elevated concentrations in most contaminant plumes. Chloride, sulfate and nitrate have a high solubility and tend to move at a similar velocity as ground water.

Inorganic constituents provide a check on the reliability of the analyses with a cation-anion balance. This is the most fundamental quality assurance/quality control (QA/QC) procedure. All waters have an equal balance of negatively and positively charged ions. The calculated error between anions and cations is generally higher for lower TDS waters. As a general rule, the sum of cations should not differ from the sum of anions by more than 2 to 3 percent. If the ratio of cations to anions does not balance, the problem is usually a typographical or analytical error; however, it can also indicate the presence of an unusual constituent which was not included in the analysis. Cation/anion analytical results with a difference of greater than 5% should be questioned. It may be an indicator that other analyses may be skewed and should be investigated for possible errors. If the relative difference between the cations and anions is small, then it is safe to assume that there are no errors in the inorganic constituents, (Hem, 1989).

Another QA/QC check is a comparison of the calculated versus the analyzed total dissolved solids values. DEQ generally has facilities analyze ground water for the major cations and anions once before permit issuance, and again near permit expiration. These analyses provide important information to evaluate impacts to ground water quality.

7.2.4.3 Field Parameters

Field parameters are ground water parameters which can be easily and accurately measured in the fieldwith portable electronic instrumentation. These include pH, electrical conductivity, temperature, dissolved oxygen and redox potential.

These field measurements serve to:

- verify when effective well purging has occurred and when ground water has stabilized to assure that the ground water sampled is representative of water in the aquifer,
- verify laboratory measurements and can indicate sample deterioration, and.
- detect abnormalities, and they can be indicative of ground water contamination, (Davis, 1988).

The preferred method of measurement is with a flow through cell which operates at the land surface and is not introduced into the borehole. If this technology is not available, then these measurements should be taken at the wellhead. Although in-situ measurements eliminate interference caused by the atmosphere, there are other interferences which may influence field measurements more dramatically. Therefore, it is recommended that field parameters be measured with a flow through cell at the land surface, or at the wellhead, (Garner, 1988).

Field measurements should stabilize to within 5% variation per casing volume removed during well purging prior to collecting ground water samples. Readings of pH, electrical conductivity, and temperature often stabilize within one casing volume while other chemical constituents take longer to stabilize. Dissolved oxygen is a better indicator of ground water stabilization since it can indicate the redox state of inorganic constituents (Puls and Powell, 1992). Dissolved oxygen is a critical field parameter to determine when representative ground water is entering the formation. Therefore, dissolved oxygen should be included in the suite of field parameters.

Redox potential is also a field parameter which provides important information on whether the ground water is in either an oxidizing or reducing condition. Field measuring devices for redox potential are not as accurate as certain laboratory methods. A qualitative method for determining reducing conditions is the use of the 2-2'dipyridyl test, which indicates the presence of ferrous iron. A positive test indicates that anaerobic conditions are present which may result in the mobilization of metals. This test is simply a screening tool. A few drops of a 0.1% 2-2'dipyridyl (or 1,10 phenathroline) solution added to a ground water sample will cause a bright red or pink reaction if ferrous iron is present, which is indicative of a reducing environment, (Heaney and Davison, 1977), (Childs, 1981). When ground water is in a reducing environment, then the sample should be field filtered rather than filtering the sample at the lab. Total digestion analysis should be requested. Metals may co-precipitate in oxidizing conditions due to a change in redox after filtration. Sampling of field parameters is discussed further in 7.7.4.1.3.

7.2.5 Monitoring Frequency

Monitoring frequency is critical to assure that samples will detect contamination if it is present, while still assuring discrete, independent samples. The frequency of ground water monitoring should be determined on a site specific basis. Factors that should be considered include information from hydrogeologic investigations, wastewater land management and loading rates, and facility type. Statistical variability of water quality data is also critical to determining monitoring frequency. For example, the maximum error about the mean, and confidence interval one is willing to accept, will determine the number of samples one needs to take in a given time period. Statistical evaluation of ground water data is discussed further in Taylor, 2003.

Monitoring frequency for compliance can be adjusted during the permit cycle. It may be decreased if it can be determined that background and seasonal variations in ground water quality have been characterized and the data supports that a less frequent sampling interval will not miss significant periods over which elevated levels may be present. Certain parameters may be monitored on a less frequent basis if reasons exist which justify less frequent monitoring. Proper well purging and sampling techniques are especially critical when samples are collected on a less frequent basis, such as annually or biannually (Barcelona et al. 1989).

Special provisions should be made for acreages being developed for wastewater land treatment. If possible, ground water monitoring should be conducted on such sites for a sufficient amount of time in order to adequately characterize baseline potentiometric and chemical characteristics of ground water *prior to initiating wastewater land treatment activities*.

7.2.6 Sampling and Sample Location Determination

Effective monitoring requires sampling, with samples taken from pre-determined locations.

7.2.6.1 Sampling

An effective system for monitoring a land application site for potential sources of ground water contamination should be capable of detecting contamination. This is done through appropriate sampling and analysis from properly designed, located, and constructed monitoring wells. This section discusses well sampling protocols and sampling location determination.

The data collected in a WLAP ground water sampling program must be of sufficient quality to allow proper analysis and interpretation and to provide evidence for the presence or absence, extent, degree, and source of contamination. For these reasons it is essential that sampling be conducted such that the data collected are precise, accurate, representative, comparable and complete.

The goal of ground water monitoring is to sample water from the geologic formation with minimal disturbance. Representative samples should indicate the condition of ambient ground water and any changes in quality as a result of the wastewater land treatment. The facility should have a monitoring plan that includes sampling and analytical protocol to assure ground water samples will be collected and analyzed properly.

The facility is responsible for having samples collected and analyzed as required in the permit. However, DEQ reserves the right to conduct site inspections and collect samples for determining compliance. It is important to assure that the resulting analytical data will adequately represent the conditions in ground water. Therefore, it is critical that sampling and analytical protocol be properly planned to assure that the sample will not be compromised by personnel, the atmosphere, the sample container, preservatives, filtering, sampling equipment, transport, or the laboratory.

The following items should be addressed in the facility's monitoring plan:

- Sampling Supplies and Equipment
- Well purging
- Sample collection
- Decontamination
- QA/QC procedures

Specific guidance related to sampling supplies and equipment, well purging, sample collection, sample packing and shipping, and decontamination are discussed in 7.6.5.

7.2.6.2 Compliance Determination and Confirmatory Sampling

Ground water quality compliance is based on results from routine sample analysis at each compliance monitoring point identified in the facility's WLAP permit. The number of samples collected, testing frequency and constituent analysis stated in the WLAP permit are minimum requirements unless otherwise stated.

Ground water quality permit violations occur when a compliance sample analysis result exceeds a level specified in the permit whether a ground water quality standard or alternate permit limit. Permits may be written such that a first exceedance will not generate enforcement action or penalties. An exceedance may be treated as a warning signal that prompts further actions such as: assessment of wastewater management practices, evaluation of the treatment capabilities and maintenance of the land application system, and assistance from qualified experts. Statistical analyses can be utilized to determine whether there are temporal or other trends in ground water. (See Taylor, June 2003). In the event a continuing violation occurs, DEQ will determine if enforcement action is warranted.

If laboratory results from compliance sampling show an exceedance of a permit limit, then confirmatory sample collection is recommended. Confirmatory samples can validate the analytical results from the previous sample and should be taken as soon as initial exceedances are known or suspected. If confirmatory samples are not collected, then the laboratory results from the original sample may be used for compliance determination. Confirmatory sampling requirements should be included in permit requirements.

Confirmatory sampling may also be conducted and used to establish trends in ground water quality or to monitor a continuing ground water quality violation. Finally, confirmatory samples are recommended, but not required, for samples collected for purposes other than compliance.

7.2.6.3 Sampling Location Determination

A monitoring network should be designed based on the information from a hydrogeologic investigation. A properly designed monitoring network is essential. Ground water monitoring wells must be properly sited to provide areal coverage of the affected site. Wells must be constructed and sampled so as to obtain representative water quality samples. Sample variability can result from temporal and spatial variability in ground water or from influences during well pumping, purging and recharge. Therefore, monitoring well location, design, construction, and sampling should be carefully planned initially to help assure that all samples will be useful and representative of ground water quality. The monitoring plan should be facility-specific.

Monitoring well locations must be approved by DEQ prior to installation to help ensure that the wells will be sited, designed and constructed properly in order to assess wastewater land treatment impacts.

The number of wells must be sufficient to ensure a high probability of detecting contamination when it is present. Specifically the placement and number of monitoring wells will depend on both aquifer and facility characteristics. Aquifer related characteristics include the ground water gradient and the site hydrogeology. Information on ground water flow direction is essential in siting wells. Aquifer hydraulics may cause spatial and temporal variability in samples, (Barcelona et al. 1989); therefore, monitoring well locations should be carefully considered prior to installation.

Facility characteristics include the volume and quality of wastewater land applied, and the fate and transport characteristics of potential contaminants. The size and configuration of the facility and land treatment acreage are particularly important. Generally, large land application sites with complex hydrogeology may require more monitoring wells than sites that are small or hydrogeologically simple. The number of wells also depends on the type of monitoring requirements. Land application sites with a long down gradient boundary perpendicular to the ground water flow direction may require additional monitoring wells.

Up gradient wells (un-impacted by the facility's activities) define ambient ground water quality, and are necessary to compare background water quality to down gradient water quality (water potentially impacted by the facility's activities). Ideally, up gradient wells should be located along the ground water flowpath toward the site. In Figure 7-3, wells 1, 2, and 3 are improperly located; wells 4, 5, and 6 are properly located.)

Background water quality characterization from up gradient wells will reduce the probability of attributing to wastewater land treatment any contamination originating off-site from other sources, or vice versa. At least one up gradient well is necessary to characterize background water quality.

Location and number of down gradient wells should be determined based on the designated point of compliance. Compliance wells must be located hydraulically down gradient of the wastewater land treatment site, along the flowpath of ground water discharging from the site. Down gradient wells must be reflective of the activity's impacts to ground water quality. At least two down gradient well are necessary in addition to an up gradient well to assess impacts and triangulate ground water flow.

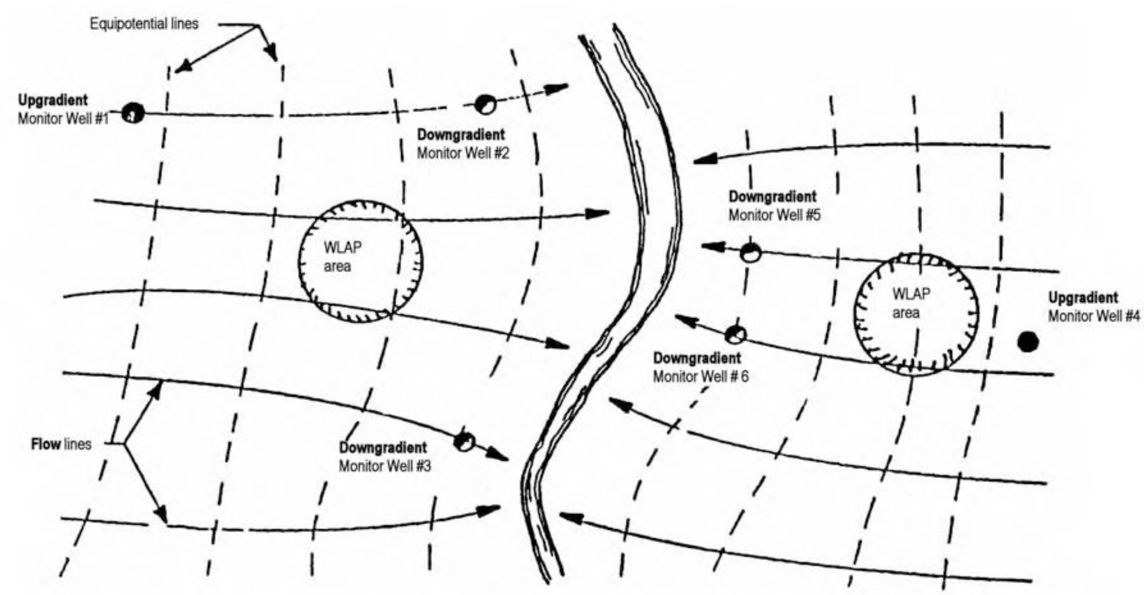

Figure 7-3. Improper and Proper Locations for Groundwater Monitoring Wells.

Ground water monitoring should be conducted in the uppermost saturated zone in addition to any other zones potentially affected by the wastewater land treatment activity. Significant water quality changes will occur in the uppermost saturated zone sooner; however, hydraulic connections between aquifers can cause contamination in lower aquifers. Ground water quality trends are determined by monitoring specific wells consistently over time.

7.2.7 Ground Water Compliance Points Monitoring

Ground water compliance monitoring involves sampling and testing ground water from approved collection points for compliance with permit conditions. Ground water compliance monitoring may not be necessary for every wastewater land treatment site (see Figure 7-5). If ground water compliance monitoring is required, compliance points for sampling and testing must be identified in the facility's WLAP permit. The number, location and frequency of sampling of compliance points are determined through the permit process.

The *point, or points, of compliance are* the locations where the facility must be in compliance with either ground water quality standards as specified in the *Ground Water Quality Rule* (IDAPA 58.01.11.200) or permit specific limits (IDAPA 58.01.11.400.05). Such standards and limits are the maximum allowable contaminant concentrations allowed at a point of compliance.

The point, or points, of compliance are determined by DEQ on a site specific basis for each facility. The point of compliance provides information to assess ground water conditions related to current and reasonable future uses of the ground water.

Ground water is typically designated as the medium where the point of compliance must be achieved since it is the primary resource which is being protected. If the point of compliance is determined to be in ground water, the following criteria should be considered in locating a point, or points, of compliance:

- The point should be as near the wastewater land treatment activity as technically feasible.
- A monitoring well must be used as the device to measure compliance.
- The monitoring wells must be located hydraulically downgradient of the wastewater land treatment activity.
- The monitoring wells must be properly constructed and screened in the uppermost ground water zone.
- If other ground water zones may be affected, then these should also be monitored by separate monitoring wells.
- The monitoring well(s) must measure the impacts of the facility's wastewater land treatment activity on ground water quality.

One well may not be adequate to measure compliance. Therefore, the point of compliance is not necessarily limited to one well, but may include an array of wells if it is determined that the information would provide a better representation of ground water conditions. Additional wells may be required if there are multiple compliance points, if the wastewater is being land applied over a large surface area, if multiple aquifers may be affected, or if the ground water flow direction varies seasonally.

Site specific conditions may warrant setting a ground water point of compliance in an alternate location to assure protection of public health and the environment. DEQ may establish alternate ground water compliance monitoring points if provided sufficient justification. A permit limit should be established in ground water at the point(s) of compliance *unless* one of the following conditions exist:

- A monitoring well will not adequately allow measurement of the impacts a wastewater land treatment activity will have on ground water quality (e.g. screened too deep, not along down gradient flow path etc.).
- The initial point where the leachate from wastewater land treatment reaches ground water cannot be determined. For example, in fractured basalt the wastewater may move along preferential pathways making it difficult to determine the location of its entry into ground water.
- The limit established for ground water at the point of compliance is met prior to release into the environment.

If it is economically infeasible or technically impractical to locate the point of compliance in ground water, monitoring limits can be established in the vadose zone directly under the wastewater land treatment site. Modeling can be done to determine what percolate concentration for a given volume would be expected to result in ground water exceeding ground water quality standards as specified in the *Ground Water Quality Rule* (IDAPA 58.01.11.200), or permit specific limits. (See discussion in .) Thus, vadose zone monitoring can still be used to measure compliance when ground water monitoring is not feasible.

7.2.8 Analytical Methods

IDAPA 58.01.11.200.d requires that analytical procedures to determine compliance “shall be in accordance with Environmental Protection Agency, Code of Federal Regulation, Title 40, Parts 141 and 143, revised as of July 1995; or another method approved by the Department.” Table 7-19, presents chemical analytical methods recommended for ground water samples. Where more than one method is given, employ the method appropriate for the type of sample, its concentration range, the availability of equipment, and necessary detection limit. Note that detection limits are generally an order of magnitude less than the Ground Water Quality Rule (IDAPA 58.01.11.200) standards for constituents assigned such numerical limits.

7.2.9 Quality Assurance and Quality Control

As discussed in Section 7.1.6.1, the facility should have a quality assurance project plan (QAPP) that includes instructions for field parameter stabilization. For more information on the development of a QAPP, refer to Section 7.1.6.

7.2.10 Data Processing, Verification, Validation, and Reporting

As with other types of monitoring, the facility’s permit will specify what parameters to monitor, when to monitor, and when results must be submitted. When reporting ground water monitoring data, describe the well location and use the monitoring serial numbers designated in the permit.

7.2.11 References

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7.3 Soil-water (Vadose) Monitoring

The vadose zone is defined, for the purposes of this document, as occupying the soil and geologic units lying between the bottom of the root zone and the top of the water table. Water samples representing water in the vadose zone are collected with lysimeters. Monitoring of this kind is referred to in this section as *soil-water monitoring* or *vadose zone monitoring*. Vadose zone monitoring is intended to be a means of providing early detection of migrating contaminants before they reach ground water.

Definitions and characteristics of soil water are discussed in EPA (1993, Section 9). This discussion is excerpted/summarized in this paragraph. Three major types of soil water can be identified in the context of sampling soil water: (1) Macropore or gravitational water, which flows through the soil relatively rapidly in response to gravity (excess of 0.1 to 0.2 bars suction); (2) soil-pore or capillary water, which is held in the soil at negative pressure potentials (suction) from around 0.1 to 31 bars of suction; and (3) hygroscopic water that is held at tensions greater than 31 bars suction. Soil-pore water moves through the vadose zone, but at much slower rates than gravitational water, whereas hygroscopic water moves primarily in the vapor form. The term soil solute or solution sampling has been used loosely in the literature to describe most sampling methods, whereas the term soil pore liquid is typically used in a more restricted sense to apply to sampling of capillary water. The chemistry of the soil solute sample can differ significantly, depending on the sampling method used. Concentrations of inorganic species generally increase as the matric potential increases (i.e. concentration is inversely related to soil pore water volume).

Vadose zone monitoring offers certain advantages for monitoring environmental response to wastewater land treatment activities. Lysimeters are less expensive and easier to install than monitor wells. Lysimeter samples (from gravity lysimeters) reflect percolate quality after wastewater has received treatment in the root zone. Vadose monitoring can provide important information regarding potential impacts of percolate to ground water in a much more timely fashion than monitoring wells if vadose and/or aquifer travel times are long. However, a disadvantage is the difficulty both in obtaining samples on a regular basis, obtaining representative samples, and interpretation of results. Instrumentation can be unreliable. Variations in soils and other factors contribute to high variability and poor reproducibility in data obtained.

Vadose zone monitoring can be used in both a management and regulatory context. For example, a threshold soil water percolate constituent concentration can be calculated above which down gradient ground water constituent concentrations would exceed acceptable levels. Such a threshold leachate concentration can be back-calculated from assumed values of ground water flow, up gradient ground water concentration, and leachate volume. This calculated threshold percolate concentration can then be compared to sample concentration data from lysimeters for management or regulatory purposes. Further discussion of utilization of lysimeter data is found in 7.7.5.2. Further discussion of when vadose zone monitoring is appropriate is found in Section 7.1 and Figure 7-5.

The remainder of this section discusses soil water monitoring objectives, instrumentation, monitoring parameters, sampling, analytical methods, QA/QC and Data Validation. Supplemental data use and interpretation is also included.

7.3.1 Monitoring Objectives

Site and management conditions that would indicate soil-water monitoring as the preferred alternative to ground water monitoring are discussed in 7.2.1. Soil-water monitoring can serve to collect early warning information about strength and volume of percolate and its potential to contaminate ground water. This is especially useful where both depth to ground water is great and percolate travel times are long, making it impractical to wait many years for indicators of contamination to appear in ground water.

7.3.2 Monitoring Instrumentation

Instrumentation is available to 1) collect soil water samples under unsaturated conditions, 2) collect soil water samples and measure percolate loss under saturated flow conditions, and 3) measure soil water content only. These types of instrumentation are discussed below. See EPA (1993, Section 9) for further details.

7.3.2.1 Soil Water Sample Collection Instrumentation

There are two basic types of soil-water monitoring instrumentation: pressure-vacuum (suction) lysimeters (hereafter pressure-vacuum samplers) and free-gravity lysimeters. This section discusses these in addition to ‘wick’ lysimeters and another recently developed sampler.

7.3.2.1.1 Pressure-Vacuum Samplers

The pressure-vacuum samplers withdraw a soil-water sample by vacuum from the soil profile. The sample is then collected by pressurizing the sampler, which forces the water sample to the surface. One of the advantages of pressure-vacuum samplers is they can collect a soil-water sample during unsaturated soil conditions when downward movement of soil-water percolate is unlikely. These lysimeters are easy to install and, for pressure-vacuum samplers, there is no depth limitation for installation. Recently developed ‘advanced tensiometers’ also have no depth limitation and are described in DOE (2002).

There is the possibility of sorption or other interferences from ceramic, or other non-ceramic, cup materials through which the soil water sample must pass. Certain organic chemicals, microorganisms, volatile chemicals and metals may present problems in this regard (EPA, 1993, p. 9-3). See also further discussion in 7.3.3.

Soil water chemistry and quantity information can be valuable to assess the effectiveness of site operations but may have limited utility for compliance purposes. The data collected from pressure-vacuum samplers will allow the evaluation of soil-water quality at the time of sample collection. The constituent concentration will depend highly on the moisture status of the soil at the time of sampling. Such samples may not be representative of percolate unless the sample was taken under free drainage conditions. If the sample was taken under unsaturated conditions, the constituent concentration would likely be higher than under saturated conditions. It would be invalid to assume samples taken under unsaturated conditions represented saturated conditions.

7.3.2.1.2 Free-Gravity (Pan) Lysimeters

Free-gravity or pan lysimeters can only collect a sample when soil-water is percolating downward. The sample collected represents the quality and quantity of soil-water percolate losses below the crop root zone.

Pan lysimeters provide information for system performance and potential ground water impacts from free drainage. A disadvantage of pan lysimeters is that no sample is collected unless soil moisture is high enough to allow for percolate losses. The lack of significant percolate accumulation, under the appropriate circumstances, may also provide important information regarding the likelihood of contaminant transport. Lack of sample can also mean that by-pass is occurring.

By-pass occurs when soil water freely drains around the lysimeter. Soil matric potential (suction or tension) around the lysimeter then increases relative to the soil matric potential above the lysimeter. Soil water then flows in response to the matric potential gradient generated and often moves laterally away from the lysimeter surface and toward the freely drained soil, thus causing lysimeter by-pass.

Other disadvantages of pan lysimeters are that installation can be complex and time consuming, and location is limited to relatively shallow depths (EPA, 1993).

7.3.2.1.3 Other Soil Water Samplers

In addition to the two types of lysimeters described above, there is also the "wick" lysimeter. The wick lysimeter collects both free drainage liquid as well as liquid held at tensions up to 0.4 bars. It offers the advantage of gathering real-time samples. Further information regarding soil water monitoring instrumentation, including method description, selection considerations, frequency of use, standard methods and guidelines, and sources of additional information can be found in EPA (1993, Section 9)

A recently developed lysimeter incorporates both the ability to obtain a soil water sample as well as capacity to measure soil water flux without the complication of by-pass. The vadose zone fluxmeter with solution collection capability is described further in Gee et al. (2003).

Table 7-3 provides a summary of soil monitoring instrumentation, including the advantages and disadvantages of each method (CLFP, 2002).

Table 7-3. Summary of soil water sampling instrumentation).

Method	Description	Advantages/Disadvantages
Soil Sampling	Soil samples are collected and analyzed for pH, ECe, Cl, NO3-N	+ Simple and reliable -Samples totals, not just solution fraction -Destructive sample -Requires a soil water balance calculation to determine whether flow occurs
Suction Lysimeter	A porous ceramic tube is placed in the soil so soil solution samples can be collected and analyzed	+ Inexpensive, simple technique to implement -Extracts soil solution that is not mobile -Known to have large measurement variability -Requires a soil water balance calculation or correlation with soil moisture to determine whether flow occurs
Pan Lysimeter	A small collection pan (1-5 ft2) is buried at a selected depth so that soil solution samples can be collected via gravity drainage for analysis. Side wall extending above the device may improve performance	+ Extracts soil solution during flow events + Provides a measure of both flow and water quality + Installation can approximate undisturbed conditions + Moderate variability among replicate samples -Relatively expensive installation costs -Will not result in samples in unsaturated soil
Basin Lysimeter	A large collection pan (50-400 ft2) is constructed and covered with soil so that soil solution samples can be collected via gravity drainage for analysis	+ Extracts soil solution during flow events + Provides a measure of both flow and water quality -Installation creates disturbed soil conditions + Large sample decreases variability -Long-term installation generally done prior to starting a project
Wick Lysimeter	A porous wick designed to match the water retention characteristics of the soil is buried at a selected depth so that solution samples can be collected using a low negative pressure.	+ Extracts soil solution at near zero water potential + Installation can approximate undisturbed conditions -Requires a soil water balance calculation to determine whether flow occurs

From CLFP (2002)

7.3.2.2 Soil Water Measurement Instrumentation

Measurement of soil water content can be done in both the crop root zone and the vadose zone. Soil moisture measurement in the root zone is typically done for irrigation scheduling purposes. Soil moisture is often measured somewhat qualitatively to determine when sufficient root zone depletion of water has taken place to require irrigation.

Measurement of soil water content in the vadose zone for contaminant fate and transport purposes requires more quantification, and is discussed in Ley et al. (2002) and in EPA (1993, Section 9). This latter discussion is excerpted/summarized in the following two paragraphs. Water state in the subsurface is measured in terms of hydraulic head in the saturated zone and negative pressure potential or suction in the vadose zone. Water movement in the vadose zone is determined by the interaction of three major types of energy potentials: (1) matric potential (the attraction of water to solids in the subsurface), (2) osmotic potential (the attraction of solute ions to water molecules), and (3) gravitational potential (the attraction of the force of gravity toward the earth’s center). Water flow in the vadose zone is strongly influenced by the moisture content (or matric potential, which is a function of moisture content), with hydraulic conductivity and resulting flow decreasing exponentially as moisture content decreases.

EPA (1993) provides information on six major techniques for measuring soil water potential and several methods for measuring soil moisture content. The measurement of soil water potential and moisture content in the vadose zone are intimately connected, and a specific measurement technique measures either potential or moisture content. Either measurement can be used to obtain the other if a moisture characteristic curve has been developed (see EPA, 1993; Section 6.3.1). Soil water instrumentation and measurement are also discussed in an agronomic context in Ley, et al. (2002).

Porous cup tensiometers are the most commonly used method for measuring soil water potential in the vadose zone. The gravimetric method is most commonly used to measure moisture content from soil samples, and the neutron probe and gamma methods are most commonly used for in situ measurement of soil moisture. Dielectric or capacitance sensors provides accuracy similar to the neutron probe without some of the disadvantages of nuclear methods. Similarly, time domain reflectometry is becoming more widely used with the advent of commercially available units. Further information regarding soil water content measurement instrumentation, including method description, selection considerations, frequency of use, standard methods and guidelines, and sources of additional information can be found in EPA (1993, Section 6). In addition, ASTM D 6642-01 (2001) can also be consulted for quantification of soil water flux.

7.3.3 Monitoring Parameters

Table 7-4 provides general guidance for soil water monitoring analytical parameters for selected wastewater land treatment scenarios. It should be noted that certain parameters can be sampled with pan lysimeters and should not be sampled with pressure-vacuum lysimeters due to interferences from either ceramic or non-ceramic materials of the porus cup. Wilson et al. (1994), Table 26.3 summarizes potential chemical interferences of various porus cup materials. Table 26.2 summarizes physical properties of porus cup materials.

Table 7-4. Common Soil Water Monitoring Analytical Parameters for Wastewater Land Treatment Facilities

Facility Type / Analytical Parameter	Municipal Facility (Class A Reuse Water)	Municipal Facility (Guideline Loading Rates)	Municipal Facility (Greater than Guideline Loading Rates)	Facility (Well Below Guideline Loading Rates)	Food Processing Facility (Guideline Loading Rates)	Food Processing Facility (Greater than Guideline Loading Rates)
Common Ions[1]	O[2]	O	?	O	?	?
pH	O	O	X	O	X	X
Electrical Conductivity	O	O	X	O	X	X
NO_3-N + NO_2-N	O	X	X	O	X	X
Fe	O	O	?	O	X	X
Mn	O	O	?	O	X	X
TDS	O	O	X	O	X	X
COD	O	O	O	?	?	X
P	O	O	?	?	?	X
K	O	O	O	?	?	X
Cl	O	X	X	X	X	X

Notes:
1. Common ions consist of the following ions: Na, K, Ca*, Mg*, SO_4, Cl, CO_3, HCO_3. These ions help characterize the chemical signature of the percolate, which can be compared to up and down gradient ground water in the determination of potential impacts.
2. Symbol Definitions: X = usually monitored; ? = monitored depending upon case specific situation; O = generally not monitored.

7.3.4 Monitoring Frequency

Frequency of monitoring should be addressed on a case-by-case basis. Lysimeters should be sampled at appropriate intervals to monitor for the changes in soil-water percolate quantity and quality. These sampling events do not necessarily need to be at regular intervals. More frequent sampling may be advisable at sites that anticipate large percolate losses within specific months, such as during the spring flush coinciding with snowmelt.

The timing of sample collection is very important to obtain representative data when using suction samplers. Pressure-vacuum samplers should be sampled to represent the largest soil-water percolate flux in order to maximize the potential to obtain samples. Sampling can be timed concurrent with irrigation and precipitation events. Timing for obtaining samples from pan lysimeters is not so critical. Percolate will accumulate in the pan lysimeter until it is sampled at the end of the quarter, or monthly, depending on the soil-water percolate storage capacity of the instrument.

7.3.5 Sampling and Sample Location Determination

7.3.5.1 Sampling

Lysimeter sampling methods are described in EPA 1993, Sections 9.2 (suction methods) and 9.3 (other methods).

7.3.5.2 Sampling Location Determination

Lysimeters for soil-water sampling should be installed below the anticipated crop root zone in order to collect percolate, which may contribute to deep drainage and potentially impact ground water. By collecting samples at this point, it is assumed that most of the treatment has already occurred in the crop root zone. This is a conservative assumption that does not account for the treatment potential in the vadose zone.

Soil-water status can vary widely over a land application site due to variations in irrigation application rates, soil hydraulic properties, and seasonally with changes in the evapotranspiration demand. The number of lysimeters on a land treatment field is dependent upon spatial and temporal variability, and acceptable quality of the data given the site-specifics and use of the data. Areas that are significantly contrasting with respect to soil type, topography, texture, and other properties should be sampled separately.

The data from each lysimeter sampling point, monitored over time, can be compared with site management to look for changes in percolate quality and volume in response to management practices, so that management/response relationships can be established. Such responses will likely be more qualitative and relative in nature.

7.3.6 Analytical Methods

Table 7-20 presents analytical methods recommended for soil water samples. Where more than one method is given, employ the method appropriate for the type of sample, its concentration range, the availability of equipment, and necessary detection limit. Note that detection limits reported by the laboratory should be significantly less than the ground water standard for constituents, which have regulatory limits.

Soil water sample volumes will vary depending on instrumentation used and time of year. It is recommended that there be a priority for testing established in the QAPP. For example, nitrate and EC require little sample volume compared with TDS, which requires about 100 ml. A reasonable priority would be to conduct nitrate-N and EC analyses first followed by COD, and TDS. Other analyses can then be added depending on the concerns of the site.

7.3.7 Quality Assurance and Quality Control

As discussed in Section 7.1.6.1, the facility should have a quality assurance project plan (QAPP). For more information on the development of a QAPP, refer to Section 7.1.6.

7.3.8 Data Processing, Verification, Validation, and Reporting

As with other types of monitoring, the facility's permit will specify what parameters to monitor, when to monitor, and when results must be submitted. When reporting soil water monitoring data, describe the lysimeter location and use the monitoring serial numbers designated in the permit.

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7.4 Soil Monitoring

Successful treatment of wastewater through land application takes place through an agronomic mechanism. Soil monitoring is a basic component of wastewater-land application monitoring and is generally necessary for continued agronomic operation and management of a land application site.

The schedule for monitoring and the parameters to be measured will depend on the type of wastewater being applied. Soil monitoring is utilized for both nutrient management and characterizing soil quality. Soil monitoring is usually not utilized for compliance purposes.

Section 7.7.7 discusses soil monitoring as used for grazing management purposes.

7.4.1 Monitoring Objectives

Soil monitoring has a dual purpose within the wastewater-land application program. The first is a *nutrient management* purpose, which is discussed in Section 4. Testing for macro-nutrients such as nitrogen, phosphorus, and potassium; pH; and micro-nutrients, are needed so that nutrient loading through wastewater and/or fertilizer can be managed to maximize both crop growth and the efficiency with which nutrients are being utilized. Extensive research on crop nutrient needs, crop response to fertilization given soil-specific nutrient status, crop health, and economic yield has been done by the University of Idaho Extension Service and others. Fertility guides and other publications are available which should be utilized in the management of wastewater land treatment facilities. Crops that appear unhealthy or for which production is noticeably decreased may indicate a need to further investigate the soil crop system to determine the problem area. For example, soils should be monitored for excessive wetness prior to subsequent application of wastewater (particularly during the wet season). Excessive wetness can effect crop growth, nutrient uptake and mobility of nutrients and metals.

The second purpose of soil monitoring is to assess soil quality. This involves characterizing the chemical and physical properties of soils of wastewater-land application sites initially during site characterization as well as over time. Soil data can be used for determining initial permit loading and management conditions, or can indicate whether loading or management changes may be indicated during the permit cycle. Long term soil characterization can reflect effects of particular land use activities. Trend data of parameters such as available nitrogen, electrical conductivity, sodium adsorption ratio (SAR), concentrations of phytotoxic constituents, salinity, and concentrations of redox sensitive species (iron and manganese) can serve as indicators of excessive wastewater loading when compared to ambient levels in agricultural soils not used for land treatment. Soil quality monitoring can signal the accumulation of constituents which may constitute a risk to ground water, given leaching conditions. Soil data can then be utilized to determine appropriate loading rates and management. Monitoring of soils should also include metals and a periodic infiltration study, if SAR levels or operational observation indicate increased runoff or runoff potential.

7.4.2 Monitoring Instrumentation

Ferguson et al. (1991) provides a description of common soil sampling equipment, and is paraphrased here. The soil probe or tube is the most desirable tool for collecting soil samples. It will give a continuous core with minimal disturbance of the soil. The cores can be divided for the various depths. There should be very little contamination of subsoil sample with surface soil when using a soil probe. A soil probe cannot be used when the soil is too wet, too dry, or frozen. If the soil is frozen, the frozen layer will need to be fractured before a probe can be used. Soil probes cannot be used in soils that contain gravel.

‘The soil auger can be used in soils that are frozen or contain gravel; however great care must be taken to obtain representative samples and to avoid mixing of soil from different depths. The use of a soil auger in wet, sticky soils will result in mixing soil from different depths. A soil auger will not effectively gather dry, powdery soils. Use a soil auger only when a soil probe cannot be used.’ A spade can also be used for surface samples, but is not satisfactory for subsoil samples. ‘A post hole digger can be used for collecting deep samples , but its use requires some special techniques.’ Galvanized, brass, bronze, or soft steel equipment should not be used as they may contaminate the sample with metals which are important micronutrients (Self and Soltanpour, 2004). Stainless steel or chrome plated tools and plastic buckets are recommended. Equipment should be clean. Wiping equipment clean between samples is generally sufficient, but washing with non-phosphate detergent and a triple rinse in de-ionized water can also be done (CES, 1997). See DEQ (2001) for further details.

DEQ (2001), Appendix ‘C’ provides soil sampling SOPs (standard operating procedures). SOPs reference monitoring instrumentation. Mahler and Tindall (1990), page 3, discuss sampling equipment. EPA (1991), Section 1 provides a complete list soil sampling equipment which may be needed. Section 4 of the same document provides a description of both hand held and power driven soil sampling equipment.

7.4.3 Monitoring Parameters

Table 7-5 shows common wastewater-land application facility types and analytical parameters recommended for on-going soil monitoring. For initial characterization of baseline soil conditions, the entire suite of analyses is recommended for all facility types.

Not included in the table are other macro- and micro-nutrients which would be monitored by facility land treatment operators or agronomists as needed to determine nutrient status of constituents which are not usually of environmental concern and wastewater land treatment sites. These include sulfate, calcium, magnesium, zinc, boron, copper, chloride and molybdenum.

Table 7-5. Common Soil Monitoring Analytical Parameters for Wastewater Land Treatment Facilities

Facility Type / Analytical Parameter	Municipal Facility (Class A Reuse Water)	Municipal Facility (Guideline Loading Rates)	Municipal Facility (Greater than Guideline Loading Rates)	Facility (Well Below Guideline Loading Rates)	Food Processing Facility (Guideline Loading Rates)	Food Processing Facility (Greater than Guideline Loading Rates)
pH	O[3]	O	?	O	X	X
Organic Matter	O	?	X	O	X	X
NH_3-N	O	X	X	?	X	X
NO_3-N + NO_2-N	O	X	X	?	X	X
DTPA-Fe[2]	O	O	?	O	X	X
DTPA-Mn[2]	O	O	?	O	X	X
Sodium Adsorption Ratio (SAR)	O	?	?	?	X	X
Specific Conductivity	O	O	X	?	X	X
P	O	O	X	?	X	X
K	O	O	O	?	?	X
Cl	O	?	?	O	?	X
Cation Exchange Capacity[1]	O	X	X	X	X	X
Texture (USDA)[1]	O	X	X	X	X	X

Note:
1. Commonly done once during each permit cycle.
2. Commonly done both at the beginning and end of the permit cycle.
3. X = usually monitored; ? = monitored depending upon case specific situation; O = generally not monitored.

A description of the analytes shown and the rationale for monitoring are provided below:

Cation Exchange Capacity (CEC): Cation exchange capacity is a measure of a soils ability to retain and exchange positively charged ions on colloidal surfaces (Bohn et al. 1979). The finer the texture (i.e. greater surface area) and the greater the OM content of the soil, the greater the CEC will generally be. The greater the CEC, the more cations, including crop nutrients, the soil can retain~~s~~. Higher CEC in soils generally indicates higher fertility.

Chloride (Cl): Chloride is commonly found in municipal and industrial wastewaters. It can move substantially un-attenuated through the soil to ground water (i.e. the ion is conservative). As such, chloride is a good indicator of contaminant movement through soil. Certain industrial wastewaters can have significant chloride concentration and may be loaded at high rates to the soil. Chloride toxicity to crops may result if concentration in the soil exceeds certain threshold levels, depending on the sensitivity of the crops. The following crop tolerance ranges are given in Biggar (1981) (in meq/L of saturated extract): low – 10 to 20; medium – 20 to 25; and high – 25 to 90+.

DTPA Extractable Iron and Manganese (DTPA Fe/Mn): Plant available iron and manganese are extracted by the chelating agent diethylenetriaminepentaacetic acid (DTPA). Fe and Mn extracted by this method are in a reduced valence state (i.e. Fe^{2+} and Mn^{2+}). Soils which have been overloaded hydraulically and/or chemically (COD) may develop reducing conditions. Reducing conditions change oxidized forms of Fe and Mn naturally resident in the soil profile to mobile forms. These forms may then leach to ground water under certain conditions. The presence of high levels of the above reduced species in soils may reflect reduced soil conditions brought on by hydraulic and/or COD overloading.

High levels of soil Fe and Mn, with respect to crop utilization, typically range from 4.1 to 10 mg/kg and 2.6 to 8.0 mg/kg respectively (Stukenholtz no date).

Sodium Adsorption Ratio (SAR): Sodium Adsorption Ratio serves as an index of the potential sodium influence in the soil. SAR values above thirteen (13) classify soils as sodic or alkali (Robbins and Gavlak, 1989), have sodium as the dominant cation, and may possibly experience infiltration problems due to deflocculation of soil colloids. Certain textures of soils can become affected at values lower than 13 (David Argyle, Hibbs Analytical Laboratories, personal communication c. 1993).

Electrical Conductivity (EC): The electrical conductivity of a water extraction of a soil is an indirect measure of the salt content in the soil. High loadings of inorganic TDS may cause salt build-up in the soil leading to crop yield decreases.

Electrical conductivities of the saturated paste extract values greater than 4 dS/m indicate saline conditions in the soil. Other *proposed* limits for defining saline soils are 2 dS/m (Bohn et al. 1979). A general soil test interpretive guide from Stukenholtz Laboratory shows ECs of 0 to 1.0 dS/m being low, 1.0 to 4.0 dS/m being medium, and 4.1 to 8.0 dS/m being high (Stukenholtz, no date).

Nitrate and Ammonium (NO_3^-/NH_4^+): common nitrogen species which are plant available and important in determining the resident nutrient status of soils. Nitrate is very mobile in the soil and is subject to leaching. Excessive nitrate leaching may cause adverse impacts to ground water.

Organic Matter (OM): Organic matter mineralizes over time to yield plant available nitrogen. It is common in crop nutrient guides to correlate the percent of organic matter with the pounds of nitrogen which will be mineralized during the growing season. This mineralization should be taken into account in wastewater land treatment site nitrogen balance calculations. Rules of thumb vary as to the amount of nitrogen released for each percent of organic matter in the soil. Taberna (no date) cites values of 50 pounds of nitrogen per acre for each percent of organic matter released for southwest Idaho, 40 for the Magic

Valley, and 35 for eastern Idaho. Extension fertility guides take soil organic matter into account when assessing the need for nutrient addition.

Texture: Soil textures are reported in the Natural Resource Conservation Service Soil Survey reports for many areas. Soil textures can be determined in the laboratory or by manual field methods if no soil survey reports are available, or to verify existing soil survey reports. Available water holding capacity, a very important parameter with respect to non-growing season wastewater loading, is a function of soil texture. Also, cation exchange capacity is correlated with soil texture (see below). Soil textures need only be determined once, since texture is a physical property of the soil and does not normally change over time.

Phosphorus: Phosphorus is relatively non-mobile in the soil and is an essential crop macronutrient~~s~~. Phosphorus is an important species which can cause eutrophication of surface waters, and associated water quality degradation problems. Phosphorus is discussed at length in Section 4.8.

Potassium: Potassium is relatively non-mobile in the soil, and is an essential crop macronutrient~~s~~. Sites which are overloaded with respect to potassium not only show very high levels in the soil profile, but distinct potassium increases from ambient ground water concentrations can often be seen down gradient.

pH: pH is a measure of the acidity/alkalinity of the soil. Generally the pH of soils does not exceed 8.3, this limit reflecting the dominating effect of carbonate on the soil chemistry. When soil pH exceeds this value, a sodic soil condition may be indicated (Robbins and Gavlak, 1989). Soil pH has an important influence on availability of crop nutrients. Productive agricultural soils generally exhibit a pH range of 6.5 to 7.5.

7.4.4 Monitoring Frequency

The frequency of soil monitoring is dependant on the type of facility, wastewater land treatment management, loading rates, and site specific factors. Table 7-6 provides recommendations for soil monitoring frequencies.

In cases where soil sampling is needed, sampling in early spring is generally indicated. Early spring sampling is done to assess the nutrient status of the soil near the commencement of the crop growing season. Fertility guides can be used to interpret the result and provide recommendations for nutrient addition for the cropping year. Soil quality status (i.e. status of non-nutrient parameters affecting crop growth and/or the environment) can also be assessed through spring sampling. Comparing spring sampling data from one year to the next can be used to estimate leaching losses of constituents such as salts. If initial and final soil concentrations are known, crop ash (inorganics) uptake and removal is known, and salts applied with wastewater, irrigation water, waste solids etc. are known, leaching losses can be estimated by difference.

Fall soil sampling after the cropping season is sometimes necessary, as Table 7-6 indicates. Additional fall sampling can be useful at facilities for which nutrient budgets (particularly nitrogen) must be closely monitored. By comparing spring and fall soil nutrient status; nutrient additions from wastewater, waste solids, and fertilizer; and crop uptake and removal; one can estimate by difference the losses of a nutrient to the environment during the growing season. In the case of nitrogen those losses would include leaching, volatilization, and denitrification. By estimating volatilization and denitrification losses, one can arrive at a growing season leaching loss estimate.

The same is true by comparing fall and spring soil nutrient status over the non-growing season, only the nutrient additions would not include fertilizer; and there would not be crop uptake and removal. One can estimate by difference the losses of a nutrient to the environment as described for the growing season. In the case of nitrogen, estimates of volatilization and denitrification may be much more tenuous because other factors, such as organic constituent and hydraulic loading and temperature, influence soil redox potential and microbial metabolic rates, which affect denitrification. This increased uncertainty makes the nitrogen leaching loss estimate more uncertain as well.

Sampling depth intervals for common types of wastewater land treatment facilities are given in the table. To characterize nutrient status for non-mobile species, such as phosphorus and potassium, crop fertility guides typically recommend sampling the 0-12 inch depth. To characterize nitrogen status, both the 0-12 inch and 12-24 inch depths are recommended.

As discussed in Section 4.2, NO_3^- is a mobile constituent. In general, shallower depths are sampled for relatively immobile nutrients. Deeper depths should be sampled for more mobile species. Depending on the type of facility, management, and loading rates, deeper layers of the soil profile should be sampled to obtain qualitative indication of movement of constituents below the crop root zone. In Table 7-6, facilities with higher loading rates, with legacy sites, and industrial facilities generally sample at depths greater than 24 inches. Recommended sampling intervals in Table 7-6 are in 12 inch increments (i.e. 0 – 12 inches; 12 – 24 inches; etc.). It is not generally recommended to select pedogenic horizons to sample; such as A, B and C horizons; since these likely occur at variable depths in a field, and may not be readily distinguishable when sampling. Also, calculating soil constituent content from concentration data is greatly simplified when a 12 inch interval is selected, as the following formula shows:

$$Soil\ \ Content\ \ (lb/acre) = Soil\ \ Constituent\ \ Concentration\ \ (mg/Kg) * 4$$

Note: The factor of 4 is approximate and appropriate for many soils, but is dependant on the bulk density of the soil.

It should be noted that if monitoring is performed more frequently than required by the permit, the results of this additional monitoring are required to be included in the annual report. If additional parameters are monitored which are not required in the permit, these data do not have to be reported.

Table 7-6. Soil Monitoring Frequency Recommendations for Common Types of Wastewater Land Treatment Facilities.

Facility Type	Municipal Facility (Class A Reuse Water)	Municipal Facility (Guideline Loading Rates)	Municipal Facility (Greater than Guideline Loading Rates)	Food Processing Facility[1] (De-Minimus Loading Rates)	Food Processing Facility (Guideline Loading Rates)	Food Processing Facility (Greater than Guideline Loading Rates)
Soil Monitoring Frequency	none	Annually: Early Spring	Annually: Early Spring	Annually: Early Spring	Annually: Early Spring	Semi-Annually: Early Spring and Fall
Sampling Depths (inches)	none	0 - 12 & 12 - 24 or refusal	0 - 12 & 12 - 24 & 24 – 36 or refusal	0 - 12 & 12 - 24 or refusal	0 – 12; 12 – 24 & 24 – 36 or refusal	0 – 12; 12 – 24 & 24 – 36 or refusal

1) Common food processing facilities in Idaho include potato (fries and dehydrated products), sugar beet, cheese, and whey processing plants. Potato fresh pack facilities, although not a food processing operation, would be included in this category.

7.4.5 Sampling and Sample Location Determination

7.4.5.1 Sampling

Soil sampling protocols for crop nutrient assessment in soils are discussed in Mahler and Tindall (1990). Sampling protocols are summarized in WLAP permits which require soil monitoring. DEQ (2001) provides soil sampling SOPs (standard operating procedures) in (DEQ 2001) Appendix ‘C’. Included are SOPs for the following:

- Collecting representative surface soil samples
- Collecting representative subsurface soil samples with hand augers, split spoon samplers, and from pits and trenches
- Decontaminating soil sampling equipment

Soil sampling should be done when there is sufficient time to complete sampling. Sampling should not be done when soils are excessively wet because compositing is difficult. Soils should not be sampled when snow covered; or have had recent fertilizer, lime, or manure applications (Iowa State University, September 2003; Mahler and Tindall, 1990). In general, several sub-samples from several locations are taken from each sampling interval (see further discussion below) and are composited by depth in a clean plastic bucket to yield a composite sample for chemical or physical analysis. If taking soil cores, the entire core from the particular depth interval should be included as a sub-sample. As described in Mahler and Tindall (1990), soil samples ‘need special handling to ensure accurate results and minimize changes in nutrient levels because of biological activity. Keep moist soil samples cool at all times during and after sampling. Samples can be frozen or refrigerated for extended periods of time without adverse effects.’ Samples can then be transported to the laboratory in a cooler.

Directions for air drying of soil samples in the following paragraph are paraphrased from A&L Plains Labs, Inc. (no date) unless noted otherwise. Samples can be air dried by spreading the sample in a thin layer on a (clean) plastic sheet. Clods should be broken up and soil spread in a layer about ¼ inch deep. The sample should be dried at room temperature. If a circulating fan is available, position it to move the air over the sample for rapid drying. Do not dry where agricultural chemical or fertilizer fumes or dust will come in contact with the samples. Do not use artificial heat in drying. When soil samples are dry, mix the soil thoroughly, crushing any coarse lumps. Take from the sample about 1 pint (roughly 1 pound) of well-mixed soil and place it in a sample bag or other sturdy, spill-proof container (generally provided by the laboratory) which has sample number, depth, date, time, field number and sampler's name (Mahler and Tindall, 1990). Documentation having sample identification describing the sample and associated information should be written. An example of a soil sample information sheet is in 7.7.6.

7.4.5.2 Sampling Location Determination

Soil monitoring units (SMUs) are specified in wastewater land application permits. SMUs are the predefined areas from which soils are sampled and composite samples are prepared. SMUs are designed so that, in as much as possible, soil properties, cropping practices and wastewater application rates are similar (CES, 1997). Obtaining representative samples is critical to getting valid and interpretable analytical results. Areas should be sampled that are similar in topography, soils, land use and management. Mahler and Tindall (1990), as excerpted and summarized here, recommend that the sampler avoid unusual areas such as eroded sections, dead furrows, fence lines, burn-row areas, wood pile burn areas, gate areas, old building sites, old manure and urine spots, areas of poor drainage, fertilizer bands where row crops have been grown, areas of fertilizer spills, and other unusual areas which would not be representative of SMU soils.

Soil samples should be taken from several different locations in the SMU. Taberna (1992) recommends taking subsamples no closer than 40 feet from the edge of the field. The sampling pattern recommended there is along a transecting loop diagonal (45 degrees) to the field (a diamond shaped transect within a square field). Mahler and Tindall (1990) recommend a zigzag meander pattern to randomly collect samples, being sure to collect samples throughout the unit. Other sampling methods besides a simple random sampling include stratified random sampling, sampling at predetermined locations based upon soil mapping, and using a systematic grid pattern. These are discussed further in CES (1997) and Jacobson (1999).

Special sampling protocols are necessary for furrow irrigated fields, areas where fertilizer has been banded, and on reduced tillage or no tillage fields. These protocols are discussed in Mahler and Tindall (1990)

It is important to note that sampling for nutrient assessment, while adequate for fertility assessment under routine farm management, introduces too much variability for monitoring practices. Soil monitoring should be performed at established locations over time to monitor for changes over time. Valid comparisons over time are not possible if sampling collects from different locations each time. In general, individual locations, grids, or sampling transects should be established to monitor for land application system performance over time.

Table 7-7 gives a recommended number of subsamples to collect based on the size of the field and purpose of sampling:

Table 7-7. Recommended Number of Soil Subsamples.

Field Size in Acres	U of I Recommended Number of Subsamples for Agronomic Nutrient Characterization[1]	DEQ Recommended Number of Subsamples for Regulatory Reconnaissance Characterization
<5	15	5
5-10	18	5
10-15	20	5
15-25	20	10
25-50	25	10
>50	30	10

1) from Mahler and Tindall, 1990

7.4.6 Analytical Methods

Table 7-24 presents analytical methods recommended for soil monitoring. Of particular importance are methods outlined in the Web site:

http://isnap.oregonstate.edu/WCC103/Soil_Methods.htm

This website consists of the on-line version of the Western States Plant, Soil, and Water Analysis Manual, Second Edition, 2003 (hereafter Gavlak et al., 2003).

Where more than one method is given, employ the method appropriate for the type of sample, its concentration range, the availability of equipment, and necessary detection limit. Note that detection limits reported by the laboratory should be significantly less than the ground water standard for constituents that have regulatory limits Quality Assurance and Quality Control

It is recommended that soil testing laboratories utilized for permit required soil analyses are participants in the North American Proficiency Testing Program (NAPT) program for soil, planed and water analyses. The NAPT program is based on the quarterly submission to participating laboratories of six soil and/or three plant materials for chemical analysis using reference methods of analysis described in the four Regional Soil Work Group publications of the Northeast Coordinating Committee on Soil Testing (NEC-67), North Central Regional Soil Testing Committee (NCR-13), Southeast Regional Soil Testing Committee (SERA-6), Nutrient Management and Water Quality Team (WERA-103) and methods outlined in the *Methods Manual for Forest Soil and Plant Analysis*, Forestry Canada.

Participating laboratories complete sample analysis and provide results to the NAPT program coordinator for statistical evaluation. Quarterly, each laboratory will provide an evaluation of their individual performance on each of the methods listed. Annually, the program will provide a report to each participant of the performance of the individual laboratory and that of the agricultural laboratory industry. An extension outreach program to aid participating laboratories in improving the quality of their analytical results will be implemented in cooperation with regional soil and plant analysis work groups and individual state, regional and provincial representatives from the Web site:

http://www.soiltesting.org/proficiencytesting.html

The following Web site has information regarding quality assurance in the agricultural laboratory:

http://isnap.oregonstate.edu/WCC103/Methods/WCC-103-Manual-2003-Lab%20Quality%20Control.PDF

7.4.7 Quality Assurance and Quality Control

As discussed in Section 7.1.6.1, the facility should have a quality assurance project plan (QAPP). For more information on the development of a QAPP, refer to Section 7.1.6.

7.4.8 Data Processing, Verification, Validation, and Reporting

As with other types of monitoring, the facility's permit will specify what parameters to monitor, when to monitor, and when results must be submitted. When reporting soil monitoring data, describe the soil monitoring unit location and use the monitoring serial numbers designated in the permit.

7.4.9 References

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7.5 Wastewater Monitoring

The quality and quantity of the effluent applied to the land treatment area should be monitored on a regular basis. Wastewater sampling and analysis plans are determined based on individual wastewater characteristics, site specific considerations, and regulatory requirements (see Section 2 and Section 7.1.6).

This section provides wastewater monitoring guidance for both municipal and industrial wastewater land application permits and includes wastewater monitoring objectives, instrumentation, monitoring parameters, sampling, analytical methods, quality assurance/quality control and data processing, verification, validation, and reporting.

7.5.1 Monitoring Objectives

The goal of wastewater monitoring at a wastewater-land application facility is to provide a timely and cost-effective assessment of the adequacy of wastewater treatment unit process operations and operation and management procedures. Wastewater chemical and flow monitoring is also critical for constituent loading calculations for permit compliance purposes.

7.5.2 Monitoring Instrumentation

The following section discusses sample collection equipment and flow measurement instrumentation.

7.5.2.1 Sample Collection Equipment

There are various types of wastewater samplers, which are designed to collect sample types described in Section 7.4.4. Refrigerated samplers are designed to take daily composite samples and keep samples at appropriate temperatures for preservation. There are other portable samplers, which can collect hourly composite samples, and can be readily moved to different locations (Metcalf and Eddy, 2003). Some composite samplers can take time-weighted samples, taking identical sample volumes over time. Other samplers can take flow-weighted samples, taking different volumes of sample proportionate to measured flows over time.

7.5.2.2 Flow Measurement

The accurate and precise measurement of wastewater flow is critical for the operation of wastewater land treatment facilities for many reasons. In-plant wastewater treatment processes, which will not be addressed here, rely on flow measurement. Important from a regulatory standpoint is flow measurement to determine both hydraulic loading and constituent loading rates for site management and permit compliance.

Flow measurement is discussed at length in various wastewater engineering texts and the reader is referred there. Important topics to consider regarding flow measurement include:

- Type and application of the flow measurement (metering) device
- Selection criteria for metering devices, and
- Maintenance of metering devices.

Metcalf and Eddy (1991), Tables 6-2, 6-3, and 6-4 provide summary information regarding application, selection criteria, and characteristics of flow metering devices respectively. Flow measurement for industrial facilities is discussed in EPA (1973). Table 7-8, from CLFP (2002), provides a convenient summary of flow measurement devices and advantages and disadvantages.

Table 7-8. Flow Measurement Examples.

Method	Alternatives	Advantages/Disadvantages
Intrusive flow meters	Impeller, paddle wheel Hot wire anemometer	- Intrusive devices can clog with solids or from biological growth - higher friction loss/pressure drop - Low pH or high Electrical Conductivity can cause failure of sensing components resulting in higher maintenance
Non-intrusive flow meters	Magnetic Ultrasonic/Doppler	+ These sensors have no parts in the flow - Higher capital cost + Often, these are used at main pump station and alternate methods are used for individual fields
Open channel flow measurements	Weir-type Parshall flume	- Requires controlled channel to establish proper conditions for measurement + Simple, reliable operation + measurements can be recorded continuously
Incoming water supply correlation	Discharge volume is estimated as a percentage of incoming water consumption	+ Supply water is clean and relatively simple to measure using meters - A correlation between incoming flow, in-plant loss, and process/rinse water discharge is required
Pump run time and output calculation	Flow for individual fields can be estimated proportionally from total flow	- Requires a master pump station flow meter or some calibration - Irrigation fields must be maintained so they operate according to specifications - Primarily applicable to sprinkler irrigation systems or surface irrigation using siphon tubes or gated pipe
In-field methods	Rain gauge/catch cans in individual fields Use of soil water measurements to calculate net irrigation	+ Approximates net irrigation (amounts actually received) rather than gross irrigation delivered - Assumptions in water budget method make method approximate; - calibration required. - Measurement of soil moisture at bottom of root zone provides useful information related to leaching - Rain gauges are applicable to sprinkler irrigation only

From CLFP (2002).

Both wastewater and irrigation water flows need to be measured. Irrigation water generally comes from one source, but can come from multiple sources (well, diverted surface irrigation water). In the latter case, each source should be metered. Irrigation water should be metered at every hydraulic management to measure application rates.

Total wastewater flow to land treatment acreage should be metered from the facility. As with irrigation water, each hydraulic management unit should be metered to measure wastewater application.

Flow data is not compromised by sample contamination, but data verification is important to consider when collecting flow measurements. In some cases flow measurements cannot be safely verified because of the position of the flow measurement device. In other cases the flow measurement device may not be properly constructed, so there is doubt about the measurements produced by the device. For example, a weir may not be level, thus the original engineering calculations used to gauge flow on the weir may not be appropriate for use with the structure as built. Data verification for flow devices should be approached carefully, because in many cases the cost of verification can be great. In some cases documentation showing proper calibration can be presented as a flow verification. All flow meters should be maintained regularly, according to manufacturer's recommendations, and should be calibrated at least once each year to insure both accurate and precise measurements are being taken.

Further discussion of flow measurement and an in-depth discussion regarding the evaluation of flow measurement devices and records for regulatory purposes is found in EPA (2004), Chapter 6. This chapter is included in this guidance in the supplementary information (Section 7.7.8), and is available at the following Web site:

http://www.epa.gov/compliance/resources/publications/monitoring/cwa/inspections/npdesinspect/npdesmanual.html

7.5.3 Monitoring Parameters

This section discusses typical chemical monitoring parameters for wastewater, irrigation water, and operations and unit process monitoring.

7.5.3.1 Chemical Monitoring Parameters

Wastewater chemical analytical parameters to be monitored in wastewater are determined from permit application data, history of the facility wastewater generation, wastewater characteristics of similar facilities and other factors. The permit may require monitoring of constituents in the wastewater for reasons other than to determine compliance with loading or other regulatory limits. Additional parameters to monitor may include toxic chemicals or substances that could upset the treatment system. These substances could be introduced from raw materials, compounds resulting from chemical interactions, or impurities in raw materials including solvents.

Municipal systems typically monitor for total suspended solids (TSS) and biological oxygen demand (BOD_5). These parameters are useful as an indicator of treatment performance prior to land application.

Table 7-9 shows common wastewater monitoring analytical parameters for wastewater land treatment facilities.

Table 7-9. Table of Common Wastewater Monitoring Analytical Parameters for Wastewater Land Treatment Facilities.

Facility Type Analytical Parameter	Municipal Facility (Class A Reuse Water)	Municipal Facility (Guideline Loading Rates)	Municipal Facility (Greater than Guideline Loading Rates)	Facility (Well Below Guideline Loading Rates)	Food Processing Facility (Guideline Loading Rates)	Food Processing Facility (Greater than Guideline Loading Rates)
Flow	X[2]	X	X	X	X	X
Total Settleable Solids	X	X	X	?	?	?
Total Suspended Solids	X	X	X	?	?	?
Turbidity	X	O	O	O	O	O

pH	X	X	X	X	X	X
Alkalinity	?	?	?	?	?	?
Sodium	O	O	?	?	?	X
NO3-N + NO2-N	X	X	X	X	X	X
TKN	X	X	X	X	X	X
BOD	?	?	?	O	O	O
SO4	O	O	O	?	X	X
Total Dissolved Inorganic Solids[1]	O	O	O	?	?	X
VDS	O	O	?	O	?	?
TDS	O	O	X	?	?	?
FDS/NVDS	O	O	?	?	?	?
Electrical Conductivity	O	X	X	X	X	X
COD	O	O	O	?	?	X
P	O	O	X	?	X	X
K	O	O	O	?	X	X
Cl	O	X	X	X	X	X
Total Coliform	X	X	X	?	?	?
Other Micro-organisms	?	?	?	?	?	?

Notes:
1. Total Dissolved Inorganic Solids generally consist of the following ions: Na, K, Ca, Mg, SO_4, Cl, CO_3, HCO_3 and other species in appreciable concentration.
2. Symbol Definitions: X = usually monitored; ? = monitored depending upon case specific situation; O = generally not monitored.

Irrigation water quality is often measured at wastewater land treatment facilities, where there is need to account for constituent loading from this source. In cases where irrigation water does not vary appreciably during the water year, nor between water years, sampling and analysis during the spring and fall of the first water year of the permit cycle is usually considered sufficient. For cases where there is more variability, additional monitoring may be necessary for chemical characterization. Typical constituents of concern are salts (as measured by TDS analysis) and total nitrogen (as measured by TKN plus nitrate-nitrogen analyses). Chloride may be necessary for sites where ground water modeling is being, or may be, conducted. Chloride is a conservative constituent (i.e. does not undergo chemical transformations in an agronomic soil environment) and can be used for modeling calibration purposes.

7.5.3.2 Operations and Unit Process Monitoring

Operations monitoring is an important component of the wastewater monitoring program. Operations monitoring includes monitoring performance of irrigation systems including inspection and cleaning of sprinklers. Observation during both growing and non-growing season during wastewater irrigation for runoff, ponding, vectors, ice build-up and other irregularities is important. Precipitation and evapotranspiration should also be monitored.

Cumulative constituent and hydraulic loadings onto hydraulic management units should be monitored throughout the application season so that sound wastewater land treatment management decisions can be made.

Lagoon water levels need to be monitored. Lagoon berms need to be inspected regularly for rodent damage and for weed control. Operation of pumps, clarifiers, screens, filter presses, centrifuges and other unit processes must be closely monitored. Ground water mounding around lagoons should also be monitored using piezometers.

Table 7-10, adapted from CLFP (2002), summarizes operations monitoring in a checklist for routine maintenance for use at a wastewater land treatment facility.

Table 7-10. Routine Maintenance Inspection Checklist for Land Application Sites Monitoring.

Feature	Condition	Recommended Action
Facility Discharge	Check primary screens for solids accumulation, amount of flow, evidence of unusual conditions	
Lagoon or Pond	Pond level, odor, scum on surface, presence of excessive solids, berm inspection for rodent damage and weed control	
Residuals Stockpile	Amount, need for land application, odor	
Main Pump Station	Current operations, flow, pressure, odor, leaks, mechanical concerns	
Transmission Piping	Leaks, odor, pressure at intermediate locations	
Booster Pumps	Current operations, flow pressure, odor, leaks, mechanical concerns	
Other Unit Processes	Monitoring of clarifier, filter presses, centrifuges, etc.	
Fields irrigated	For each field: list irrigation run times, process water or supplemental water supply, odor	
Constituent Loading	Cumulative constituent and hydraulic loadings throughout growing and non-growing seasons	

Feature	Condition	Recommended Action
Fields condition	For each field: assess irrigation uniformity, runoff, erosion, irrigation system condition, odor, solids on surface, ice buildup, ponding, vectors,	
Crop Condition	For each field: general crop health, need for farming activities	
Samples Collected	List samples taken	

Adapted from CLFP (2002).

7.5.4 Monitoring Frequency

Wastewater monitoring frequency is determined based on the measured or estimated variability (see Section 7.1.3). Other factors for determining sampling frequency include the following:

- Size and design capacity of facility
- Type of treatment
- Compliance history
- Number of pollutant sources from a facility
- Cost of monitoring relative to the facility's capability and benefits obtained
- Environmental significance of wastewater constituents
- Detection limits and analytical precision/accuracy
- Production schedule of the facility (seasonal, daily, year round, etc.)
- Plant washdown or cleanup schedule
- Batch type process and discharge or continuous operation

The number of samples necessary to determine compliance for total coliform is related to the degree of public exposure, as rated by total coliform counts in wastewater (see Table 7-11). The WLAP rule (IDAPA 58.01.17.600.07) specifies the use of the median sample value for the last three to seven test results to determine compliance, depending on the effluent classification.

Table 7-11. Total Coliform Testing Frequency and Compliance Determination for Municipal Systems

Wastewater Category	Median Coliform Limit	Single Sample Maximum Value**	Recommended Sampling Frequency	Compliance Determination Method
Class A	Filtered, Total Coliform limit: 2.2/100 ml *	23/100 ml	Daily when land application system is in operation, or project specific	O&M manual must include provisions to divert effluent or shut down application system whenever bacterial excursions occur or may occur; Median value of last 7 results, rolling basis
Class B	Total Coliform limit: 2.2/100 ml	23/100 ml	Twice per week when land application system is in operation	Median value of last 7 results, rolling basis
Class C	Total Coliform limit: 23/100 ml	240/100 ml	Weekly when land application system is in operation	Median value of last 5 results, rolling basis
Class D	Total Coliform limit: 230/100 ml	2400/100 ml	Twice per month when land application system is in operation	Median value of last 3 results, rolling basis
Class D	Too Numerous to Count – Not Applicable	Not Applicable	Twice per month when land application system is in operation	Not Applicable

Notes:
* This category requires filtration performance standards (turbidity or TSS) prior to disinfection.
** The facility shall include provisions to divert effluent or shut down application system whenever bacterial excursions occur or may occur

Municipal wastewater land application permits should include a total coliform maximum limit, in addition to the median limit. For compliance, using the median value allows a certain number of individual samples to have unlimited bacteria counts. Including a single sample maximum value provides needed public health protection, and requires facilities to monitor their disinfection systems more closely. See Table 7-11 for suggested maximum limits according to wastewater category.

Municipal permits typically have hydraulic loading rates be calculated on a monthly basis. If a system is having problems managing the site properly, a weekly basis may be more appropriate.

Frequency of wastewater constituent monitoring for industrial wastewater land application facilities is summarized in Table 7-27. Frequency of wastewater constituent monitoring for municipal wastewater land application facilities is summarized in Table 7-28.

7.5.5 Sampling and Sample Location Determination

7.5.5.1 Sampling

Detailed information for developing a wastewater sampling program is found in Section 7.1.6 in the context of development of the quality assurance project plan (QAPP). The publication, *Monitoring Industrial Wastewater*, EPA, 1973, can also be consulted. The information is also applicable to municipal wastewaters. There are several types of wastewater samples that can be collected: *grab*, *composite*, and *continuous sampling*, all of which are discussed in the following.

The wastewater sample type will depend on several factors:

- The parameter to be monitored.
- The temporal and spatial variability of the wastewater sampled; and
- The type of limit. Limits based on instantaneous or one hour values may be sampled using grab sampling techniques. Limits based on average values or daily maximums may be sampled using time or flow proportional composite samples. This is acceptable for certain conventional pollutants, nutrients, and bio-accumulative pollutants, for which percent removal and total loading to the receiving water are of concern.

7.5.5.1.1 Discrete Grab or Sequential Grab Samples

A wastewater grab sample is an individual sample collected in less than 15 minutes time. It represents more or less "instantaneous" conditions as discussed in Section 7.1.4. Grab samples should be used when:

- Wastewater characteristics are relatively constant.
- The parameters to be analyzed are likely to change with storage such as temperature, dissolved gasses, residual chlorine, soluble sulfide, cyanides, phenols, microbiological parameters and pH.
- The parameters to be analyzed are likely to be affected by the compositing process such as oil,grease, and volatile organic compounds.
- Information on variability over a short time period is desired.
- Composite sampling is impractical or the compositing process is liable to introduce artifacts of sampling.
- The spatial parameter variability is to be determined. For example, variability through the cross section and/or depth of a stream, lagoon or other large body of water.
- Wastewater flows are intermittent from well-mixed batch process tanks. Each batch dumping event should be sampled.

Another type of grab sample is sequential sampling. A special type of automatic sampling device collects relatively small amounts of a sampled stream, with the interval between sampling either time or flow proportioned. Unlike the automatic composite sampler, the sequential sampling device automatically retrieves a sample and holds it in a bottle separate from other automatically retrieved samples. Many individual samples can be stored separately in the unit, unlike the composite sampler, which combines aliquots in a common bottle. This type of sampling is effective for determining variations in media characteristics over short periods.

7.5.5.1.2 Composite Samples

As discussed in Section 7.1.4, a composite sample consists of a series of individual samples collected over time into a single container, and analyzed as one sample. Composite sampling is employed when time or flow-weighted constituent concentration averages are needed (see below), or when mass per unit time information is needed. There are two general types of composite samples.

- **Time composite samples** collect a fixed volume at equal time intervals and are acceptable when flow variability is not excessive. Automatically timed composited samples are usually preferred over manually collected composites. Composite samples collected by hand are appropriate for infrequent analyses and screening. Composite samples can be collected manually if subsamples have a fixed volume at equal time intervals when flow variability is not excessive.
- **Flow-proportional compositing** is usually preferred when Wastewater flow volume varies appreciably over time. The equipment and instrumentation for flow-proportional compositing have more downtime due to maintenance problems. When manually compositing Wastewater samples according to flow where no flow measuring device exists, use the influent flow measurement without any correction for time lag. The error in the influent and wastewater flow measurement is insignificant except in those cases where extremely large volumes of water are impounded, as in reservoirs. Use composite samples when either determining average concentrations, or calculating mass loading/unit of time.

There are numerous cases where composites are inappropriate. Samples for some parameters such as pH, residual chlorine, temperature, cyanides, volatile organic compounds, microbiological tests, oil and grease, and total phenols should not be composited. They are also not recommended for sampling batch or intermittent processes. Grab samples are needed in these cases to determine fluctuations in wastewater quality.

The compositing time period and frequency of aliquot collection should be determined. Whether collected by hand or by an automatic device, the time frame within which the sample is collected should be specified in the permit. The number of individual aliquots which compose the composite should also be specified. A minimum of four aliquots during a 24-hour period is common for wastewater composite samples.

7.5.5.1.3 Continuous Monitoring

Continuous monitoring is another option for a limited number of parameters such as total organic carbon (TOC), temperature, pH, conductivity, fluoride and dissolved oxygen. Reliability, accuracy and cost vary with the parameter. Continuous monitoring can be expensive, and has limited applicability to wastewater land treatment facilities. The environmental significance of the variation of any of these parameters in the wastewater should be compared to the cost of continuous monitoring equipment available.

Process control monitoring has been generally discussed both in Section 7.1.1 and Section 7.4.3.2. It refers to monitoring of internal waste streams in order to verify that proper waste treatment or control practices are being maintained. The wastewater treatment process will determine the types of process control monitoring needed.

Additional sampling information is given in the *Handbook for Sampling and Sample Preservation of Water and Wastewater*, EPA (1982).

7.5.5.2 Sampling Location Determination

Permanent sampling locations should be determined and identified in permit application materials. The permit applicant should provide a description of the wastewater sampling station location and in most cases, a line drawing and description of the flows and processes involved in wastewater treatment.

The point at which a sample is collected can make a large difference in the monitoring results. Important factors to consider in selecting the sampling station are:

- The flow at the sampling station should be measurable.
- The sample should be representative of the wastewater during the time period which is monitored.
- If possible, the sample should be collected where the wastewater is well-mixed. Therefore, the sample should be collected near the center of the flow channel, at a depth of approximately half the total depth, where the turbulence is at a maximum and the possibility of solids settling is minimized. Acceptable sampling locations can include near a Parshall flume or at a location in a sewer with hydraulic turbulence. Weirs tend to enhance the settling of solids immediately upstream and the accumulation of floating oil or grease immediately downstream. Such locations should be avoided for sampling.
- Skimming the water surface or dragging the bottom should be avoided.
- In sampling from a mixing zone, cross-sectional sampling should be considered. Dye may be use as an aid in determining the most representative sampling points.
- If manual compositing is employed, the individual sample bottles must be thoroughly mixed before pouring the individual aliquots into the composite container.

It is often convenient to combine a flow measurement station with a sampling station. When flumes are used for flow measurement, the sample is usually well mixed. Wastewater samples should be collected at a location which represents wastewater quality which is to be land applied. More than one wastewater sampling station may be necessary for two separate wastewater streams which are not mixed, but are land applied separately.

7.5.6 Analytical Methods

Table 7-29 presents analytical methods which are recommended for wastewater monitoring. Where more than one method is given, employ the method appropriate for the type of sample, its concentration range, the availability of equipment, and necessary detection limit. As discussed in Section 7.1.5, practical quantitation limits (PQLs) reported by the laboratory should be appropriate for constituents which have regulatory limits.

For chlorine residual “free” chlorine should be specified. Metcalf & Eddy (1991) states “the main reason for adding enough chlorine to obtain a free chlorine residual is that usually disinfection can then be ensured.” Chlorine residual monitoring and monthly reporting should be required in permits.

7.5.7 Quality Assurance and Quality Control

As discussed in Section 7.1.6.1, the facility should have a quality assurance project plan (QAPP). For more information on the development of a QAPP, refer to Section 7.1.6.

7.5.8 Data Processing, Verification, Validation, and Reporting

As with other types of monitoring, the system’s permit will specify what parameters to monitor, when to monitor, and when results must be submitted. When reporting wastewater monitoring data, describe the sampling location and use the monitoring serial numbers designated in the permit.

Municipal permits should generally require monthly reports for hydraulic loading rates, chlorine residual, and total coliform. The need for this should be determined by the regional office. If monthly reports are necessary to maintain adequate system oversight, it can be specified in the permit.

7.5.9 References

CLFP. California League of Food Processors. September 20, 2002. Final Report: Manual of Good Practice for Land Application of Food Process/Rinse Water for California League of Food Processors. Brown and Caldwell, Kennedy Jenks, Komex H_2O Science.

EPA. U.S. Environmental Protection Agency, Methods for Chemical Analysis of Water and Wastes. Environmental Monitoring Systems Laboratory-Cincinnati (EMSL-Cllll), EPA-600/4-79-020. Revised March 1983 and 1979 where applicable.

EPA. U.S. Environmental Protections Agency. 1982. Handbook for Sampling and Sample Preservation of Water and Wastewater. EPA-600/4-82-029.

EPA. U.S. Environmental Protection Agency. July 2004. NPDES Compliance Inspection Manual. Office of Enforcement and Compliance Assurance, Washington D.C.

Greenberg, A.E. et al. (eds). 1992. Standard Methods for the Examination of Water and Wastewater - 18th Edition.

Bordner, R.H., and J.A. Winter, eds. 1978. "Microbiological Methods for Monitoring the Environment, Water and Waste." Environmental Monitoring Systems Laboratory, U.S. Environmental Protection Agency. EPA-600/8-78-017.

Association of Official Analytical Chemists, Official Methods of Analysis (AOAC). 1990 15th Edition.

Metcalf and Eddy (Eds. Tchobanoglous, G., and F. L. Burton). 1991. Wastewater Engineering – Treatment, Disposal, and Reuse. Metcalf and Eddy Inc. 3rd Edition. McGrawHill, Inc. 1334 pages.

Metcalf and Eddy (Revised by Tchobanoglous, G., F. L. Burton, and H.D. Stensel). 2003. Wastewater Engineering – Treatment, Disposal, and Reuse. Metcalf and Eddy Inc. 4th Edition. McGrawHill, Inc. 1819 pages.

7.6 Crop Monitoring and Yield Estimation

7.6.1 Monitoring Objectives

Crop monitoring includes maintaining chronology of cropping activities, plant tissue monitoring, and crop yield estimation. Cropping activity chronology would include dates of planting, harvest, tillage operations, fertilizer application, and dates where crop health was observed (CLFP, 2002 p. 10-18). Crop yield estimation is important to calculate crop uptake of nutrients and salts for regulatory compliance purposes.

Plant tissue monitoring is generally used to ascertain the nutrient status of a growing crop for managing fertilizer applications for maximizing crop yield and quality – i.e. for nutrient sufficiency and deficiency determination. Plant tissue monitoring is also conducted to determine feed value, nutrient toxicity and, in certain instances, the presence and concentration of toxic compounds, of a harvested crop.

The purpose of plant tissue monitoring as it pertains to permitted wastewater land treatment facilities is to determine crop uptake of nutrients and other constituents, and their removal from the treatment acreage. Crop uptake monitoring is discussed primarily in this section. Crop uptake monitoring data are used in nutrient and other constituent balance calculations in order to help characterize constituent losses to the environment. For example, if it is known how much nitrogen is in the soil in early spring, the amount of nitrogen applied in wastewater and fertilizers, how much is in the soil after harvest, and how much is taken up and removed by the crop, the difference represents losses of the constituent to the environment. Such loss estimates can then be partitioned into various pathways of loss, such as leaching and atmospheric losses. Estimates of leaching losses can then be used in conjunction with site-specific environmental data and modeling to help characterize the potential and degree of environmental impacts, such as those to ground water.

7.6.2 Monitoring Instrumentation

See Section 7.6.5.1 for description of sampling equipment used for plant tissue monitoring.

7.6.3 Monitoring Parameters

Parameters of interest for plant tissue monitoring at wastewater land application facilities include nitrogen, phosphorus, and some measure of inorganic salts.

7.6.3.1 Nitrogen

Nitrogen in plant tissue is typically measured from TKN analyses. TKN measures reduced forms of nitrogen in plant tissue including proteins and nitrogen in cellular tissues. The

TKN analyses does not measure nitrate in plant tissue, so nitrate should be analyzed as well.

Nitrate concentrations in plant tissue can be significant in crops which have been grown with an abundance of supplied nitrogen. The presence of elevated nitrate levels in plant tissue can indicate that luxury consumption – crop uptake above the amount of nutrient a crop would normally need to take up to satisfy growth and development demands – has likely occurred.

Alternately, elevated nitrate levels in plant tissue can indicate nutrient stress; moisture stress; or cloudy, cool weather that can cause slow metabolism of nitrate to ammonia in the synthesis of amino acids in the plant (reference).

Nitrate is also important to characterize because it can be toxic to animals. Lethal dose is determined by the nutritional state, size, and type of animal; and consumption of feed other than nitrate-containing material:

- Ruminant animals are most sensitive to nitrate intake, because nitrate is converted to nitrite in the rumen and nitrite binds and inactivates hemoglobin in the bloodstream.
- Concentrations of less than 1,000 mg/kg in the feed ration are acceptable for all cattle.
- Concentrations greater than 2,000 are not suitable for the entire feed ration and should be blended with other feed.
- Potentially lethal level of nitrate-nitrogen in animal feed is over 2,100 mg/Kg (Ensminger et al., 1990).

Nitrate in plant tissue can be chemically reduced to benign forms by green-chopping and ensiling and crop. This is a common practice at many wastewater land treatment facilities, not only for the removal of nitrate, but to achieve rapid removal of the harvested crop so that wastewater land treatment activities can proceed with only minimal delays.

7.6.3.2 Phosphorus

Phosphorus is also important to assess in plant tissue. A significant amount of phosphorus can be taken up by the crop and removed at harvest. Accounting for these amounts is important when determining permit limits for phosphorus loading to land application sites.

7.6.3.3 Salts

Inorganic salts are important to assess in plant tissue. Accounting for inorganic salt uptake in crops can be significant when modeling salt (i.e. TDS) impacts to ground water. The ash content of plant tissue is assumed to represent these salts. A significant amount of inorganics are taken up by the crop and removed at harvest.

7.6.4 Monitoring Frequency

Plant tissue monitoring for obtaining data for nutrient and other constituent balances is done at harvest. For hay crops, each cutting is a harvest, so samples should be obtained from each cutting and each hydraulic management unit. For crops that are harvested once at the end of their respective growing seasons, sampling should take place then.

7.6.5 Sampling and Sample Location Determination

7.6.5.1 Sampling

Only the plant parts that are removed from the site need be sampled. In the case of a hay crop, the entire plant top is cut and removed, so the entire plant should be sampled. In the case of small grains, if the grain and stover (above-ground plant parts excluding the seed) are both harvested and removed, both should be sampled. If the stover is left on site, then only the grain should be sampled.

CES (1997) outlines plant tissue sampling methods, which are summarized here. Plant tissue samples of green, growing crops such as forages should be taken immediately prior to harvest. Sampling forage crops immediately prior to harvest can result in 10 to 20 percent higher nitrogen levels because of plant tissue degradation following harvest. Samples should be collected to be representative of the crop at the time of harvest or just prior to harvest. Sampling of small areas of the field where plants are under severe moisture or temperature stress is not recommended. Plants that are dust covered, mechanically injured, diseased, or dead should not be sampled (Walsh and Beaton, 1973). The exception to this is when mechanical injury, disease or crop death is representative of the material being harvested. Crop tissue should be tested in these cases.

Samples should be collected at random locations in the hydraulic management unit. Specific crop types require particular sampling methods. For harvested grain, bean, silage or green chop, one grab sample from each day of harvest should be collected. They should be placed in paper bag and refrigerate, then mixed and a composite sample (1 liter wet or ½ liter dry) sent to the laboratory. For bailed hay, collect three composite samples from each harvest from each field. Each hay sample should be composited from at least ten cores from the ends of randomly selected bales. Then mix and send to the laboratory.

Potatoes require special sampling methods due to their size and the presence of two harvested plant parts, namely the potato and the vines. Collect on grab sample per day during harvest consisting of at least five potatoes. Quarter each potato and discard three of the quarters. Retain one quarter from each potato for a daily grab sample. Keep subsamples refrigerated and send all quarters to the laboratory for analysis. If the potato vines are to be burned, vine yield and nutrient (nitrogen only) uptake by the vines should be measured. Collect the vines from three four-foot sections of row in four locations in each hydraulic management unit (CES, 1997). Then reduce the sample size by splitting the pile of collected vines prior to shipping to the laboratory. Refrigerate after sampling and send at least 1 liter, but preferably one gallon, of volume of sample to the laboratory.

For forage crops, each sample should consist of the clippings from a minimum ten square feet of area. A square wooden frame or a wire whoop placed on the forage is effective to delineate the area to be sampled. The frame should be randomly dropped along a transect or grid pattern. The plants should be clipped within the frame at the same level that would result from the mechanical harvesting equipment. Hand operated or other clippers may be used. Place each composite sample in a large paper bag so the sample can ‘breath’ (some sources recommend a perforated plastic bag). Put the sample in a cool place and deliver to the laboratory within two hours (CES, 1997). Ship or store samples in a chilled cooler if delivery in two hours cannot be accomplished. Delivery within 24 to 48 hours is acceptable if samples are kept dry and chilled in 'breathable bags. Illinois (no date) recommends a quick washing of plant tissue in a 0.1 – 0.3 percent non-phosphate containing detergent accompanied by three rinses in de-ionized water, in order to remove any dust, fertilizer, pesticide or other residues from the leaf surfaces.

As an alternative to collecting and transporting fresh plant tissue samples to the laboratory within short time-frames, samples may be dried in a clean muslin bag or tray inside a forced draft oven at 65 C for 48 hours. Tissue samples may then be ground after drying and placed in a bottle and allowed to dry for an additional 24 hours at 65 C. After this, samples are ready for analyses (Illinois, no date). Walsh and Beaton (1973) may be consulted for further information regarding plant tissue sampling and analyses.

7.6.5.2 Sampling Location Determination

As mentioned in 7.6.4, each harvest of every crop on a hydraulic management unit should be sampled. Sampling within the hydraulic management unit is addressed in 7.6.5.1.

7.6.6 Analytical Methods

Table 7-12 presents analytical methods that are recommended for plant tissue sample analysis.

Table 7-12. Plant Tissue Analyses.

Parameter	Abbreviations	Units	Recommended Methods(1)
Crude Protein	--	% by weight	TKN * factor(2)
Total Kjeldahl Nitrogen	TKN	% by weight	978.04
Total Combustible Nitrogen	TCN	% by weight	990.03 Note: This method yields results comparable to TKN above and is becoming more commonly used.
Nitrate + Nitrite	NO3 + NO2	% by weight	968.07
Ash	--	% by weight	930.04
Moisture	--	% by weight	930.05

1. Association of Official Analytical Chemists, Official Methods of Analysis (AOAC). 1990 15th Edition. All methods cited in this appendix are recommended methods. Other comparable methods yielding the same interpretive results are acceptable unless otherwise stated in the Land Application of Wastewater Permit.
2. Use 6.25 for mixed feeds and forages; 5.72 for grains.

7.6.7 Quality Assurance and Quality Control

As discussed in Section 7.1.6.1, the facility should have a quality assurance project plan (QAPP). For more information on the development of a QAPP, refer to Section 7.1.6.

7.6.8 Data Processing, Verification, Validation, and Reporting

As with other types of monitoring, the facility's permit will specify what parameters to monitor, when to monitor, and when results must be submitted. When reporting plant tissue monitoring data, describe the sampling location (hydraulic management unit) and use the monitoring serial numbers designated in the permit.

7.6.9 Crop Nutrient Content Reference Values

Wastewater land treatment sites that are loaded at agronomic rates or up to 150% of the agronomic rate are often required to have crop chemical analyses performed and make crop nutrient removal calculations. It may be appropriate for certain sites loaded at or below agronomic rates to use crop nutrient concentration values found in standard tables. Table 7-30 compiles nitrogen contents of a wide variety of crops. Sources of the data are documented in the footnotes. Ducnuigeen et al. (1997), Tables B-1, B-2, and B-3 provide a comprehensive source of non-crop species nitrogen and phosphorus uptake information. These tables are found at the following Web site:

http://www.potomacriver.org/info_center/publicationspdf/ICPRB97-4.pdf.

Table A-2 of Martin et al. (1976) provides typical ash, nitrogen, phosphorus, and moisture content information for cereal crops. Table A-1 of Martin et al. (1976) gives weight per bushel information for cereal crops. These two tables are included in Appendix Y below. The USDA NRCS web site

http://www.nrcs.usda.gov/technical/land/pubs/nlapp1a.html

also provides nitrogen, phosphorus and potassium uptake rates. Bushel weights of common commodities are also found in Table 31 of Midwest Laboratories (no date).

Typical yields for common Idaho crops by county and by year can be obtained from the Idaho Department of Agriculture, Agricultural Statistics Division. A useful Web site is the following:

http://www.nass.usda.gov:81/ipedbcnty/c_groupcrops.htm

7.6.10 Crop Yield Estimation

CES (1997) provides guidance on how to estimate crop yields from wastewater land treatment sites. This guidance is summarized here. The date of harvest should be recorded, as should the harvest method (bale, green chop, other) and crop type. The crop yield from each harvest, such as multiple cuttings, should be recorded. For forage crops, either the total measured weight method or average bale weight methods can be used, as discussed below. Both methods require the measurement of moisture content of the harvested material to calculate dry weight.

7.6.10.1 Total Measured Weight Method

The total measured weight method requires each truckload of harvested material to be weighed. This method is best suited to crops that are immediately removed from the field, including corn grain, corn silage small grains, potatoes, and green chopped hay.

The methodology is as follows:

1. Measure each full truckload weight and empty truckload weight. The difference is the individual truckload weight of harvested material.

12. Sum all individual truckload weights to obtain total harvested weight.

13. Calculate the total dry matter weight as follows:

    Total harvested weight (lbs) * (1 – moisture content expressed as a fraction) = total dry matter content (lbs)

14. Convert total dry matter to average yield as follows:

    Total dry matter content (lbs) divided by field size (acres) = average yield (lb/acre)

7.6.10.2 Average Bale Weight Method

The average bale weight method is best suited for forage crops or other crops removed in uniform discrete units. This method involves weighing at least 20 randomly chosen bales or one truck load of at least 20 randomly chosen bales. The average weight per bale of these bales is then calculated from individual bale weights. The total harvest weight consists of counting the number of bales from a field and multiplying by the average weight per bale. The total harvest weight of the field is converted to total dry matter weight and average yield in the manner described in nos. 3) and 4) above.

7.6.11 References

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7.7 Supplemental Information

7.7.1 General Discussion Supplemental Information

The following supplemental information provides additional information on determining sample size and a recommended QA/QC Plan outline.

7.7.1.1 Statistical Methodology for Determining Sampling Frequency

The following is a method to calculate the sample size (related to sample frequency) required to meet specified accuracy and confidence levels when characterizing the chemistry of wastewater. This methodology is incorporated into the wastewater sampling frequency spreadsheet, *WW_Sampling_Frequency_Tool.xls*. This methodology may be used for determining sampling frequencies of other sampled media as well.

In the spreadsheet, wastewater chemical oxygen demand (COD) concentration from a potato processing WLAP site is used as example data. The true mean is usually unknown, so it is estimated by a flow-weighted average, using:

$$\hat{\mu} = \frac{\sum_{i=1}^{m} Q_i C_i}{\sum_{i=1}^{m} Q_i}$$

Equation 7-1Estimating mean using a flow-weighted average.

Where:

$\hat{\mu}$ = estimated mean or flow weighted average

Q_i = the flow rate in the ith time interval

C_i = the ith constituent concentration

m = the total number of observations

In the *WW_Sampling_Frequency_Tool.xls* spreadsheet, the time interval is one day, therefore i = 1, 2, ..., 366. The weighted average of COD concentration (mg/l) is shown in cell C372 of the Data Input worksheet. Sum (Q_i), the total flow rate (MG), is shown in cell B371 of the *Data Input* worksheet.

Sample size, n, is calculated based on:

$$n = \frac{z^2_{\alpha/2} s^2}{B^2}$$

Equation 7-2. Calculating sample size.

Where:

n = sample size required. On the *Stat Output* worksheet of the WW_Sampling_Frequency_Tool.xls, the required n is rounded to the next larger integer value of the calculated n.

$z_{\alpha/2}$ = the $(\alpha/2)^{th}$ percentile of the standard normal distribution

α = the significance level, the confidence level is $(1-\alpha)100\%$. Conventionally, α is specified at 0.05, which gives 95% confidence interval of the estimated parameter. Other confidence levels may be more appropriate depending upon the medium, parameter, and purpose of the data.

s = standard deviation of the sample

B = maximum allowable error in the estimation of the mean and is denoted either by percentile of the mean or as an absolute value.

The *Stat Output* worksheet provides several maximum errors, in estimating the mean (B) and confidence levels, to choose from, and their corresponding sampling frequency requirements (n). An example of the spreadsheet output is shown in Figure 7-4.

Sample Frequency Statisical Output Calculations

Sample size (n) based on different levels of accuracy and confidence
error allowable (B) is taken as percentage of the mean.
following is based on COD, note that final n should be rounded to the next large integer

				confidence level				
B (% mean)	B	Upper	Lower	80%	85%	90%	95%	99%
5	144	3028	2739	99	126	164	233	401
10	288	3172	2595	25	32	41	59	101
15	433	3316	2451	11	14	19	26	45
20	577	3460	2307	7	8	11	15	26
25	721	3604	2163	4	6	7	10	17
30	865	3749	2019	3	4	5	7	12

Notes:
1) 'B' is the maximum error about the mean one is willing to accept, as expressed as a percent of the mean concentration or as expressed as a number (column B).
2) The upper and lower bounds from the mean with a given 'B' are shown in columns C and D.
3) Need >20 data points; assume normality of data. Use data from several years if necessary to obtain 20 data points.

Figure 7-4. Example of Statistical Output of the Spreadsheet: WW_Sampling_Frequency_Tool.xls

7.7.2 Recommended Contents for a Facility Quality Assurance/Quality Control Plan

Revision 1 12/12/05

Template for Quality Assurance Project Plan

Prepared: March 30, 2001

EPA Documents Relevant to Preparation of a Quality Assurance Project Plan

EPA Order 5360.1 CHG 1, **Policy and Program Requirements for the Mandatory Agency-Wide Quality System** requires that guidelines in ANSI/ASQC E4-1994 AMERICAN NATIONAL STANDARD **Specifications and Guidelines for Quality Systems for Environmental Data Collection and Environmental Technology Programs**, and EPA QA/R-5, EPA **Requirements for Quality Assurance Project Plans** be used in describing a quality management system.

1

Revision 1 12/12/05

1.1 Title and Approval Page

Project Title

Organization
Address
Town, State

Revision: 0
Date:

Applicant Approval:

Approval Signature:
Phone:

IDEQ Acceptance and Approval:

Organization Title: Idaho Department of Environmental Quality

Address: 1410 North Hilton St. Boise, ID 83706

IDEQ Approval:

Approval Signature:
Phone:

2

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4.0 DATA VALIDATION AND USABILITY

4.1 Data Review, Validation, and Verification Requirements

4.2 Validation and Verification Methods

4.3 Reconciliation with User Requirements

7.7.3 Ground Water Monitoring Supplemental Information

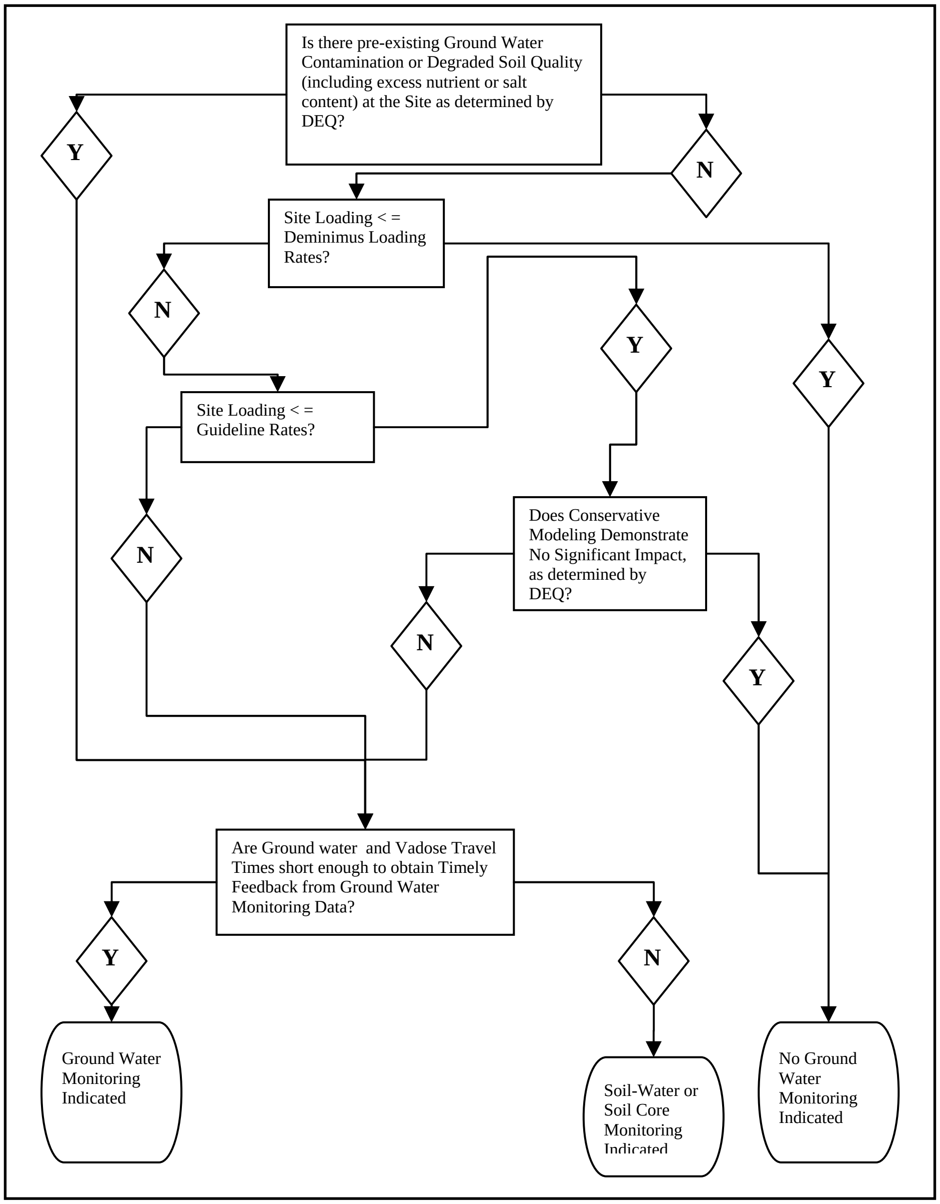


Figure 7-5. Decision Flowchart to Determine Whether Ground Water Monitoring is Needed at a Wastewater Land Application Site

7.7.3.1 Monitoring Well Construction

Details regarding the construction of monitoring wells are found here. Included in this appendix are discussions of drilling methods; selection of screened interval depths; casing materials; seals, packing and grouting; and monitoring well development.

7.7.3.1.1 Drilling Methods

There is a variety of different types of drilling methods. Care should be taken to minimize the introduction of contaminants into the borehole during drilling since this may compromise the analytical results of the ground water quality samples collected from this well. Table 7-13, summarizes the most common drilling methods.

Table 7-13. Drilling Methods.

Method	Environment	Advantages	Disadvantages
Hollow-stem continuous flight auger	Glaciated or unconsolidated materials (< 150 ft)	mobile fast inexpensive no drilling fluids minimal disturbance to formation	cannot be used in loose large cobbles drilling depth 150 ft
Cable tool	Glaciated or unconsolidated materials (any depth), Consolidated formations (any depth), excellent for glacial till, effective in boulder Environments	excellent for formation sample collection minimal water used easy detection of water table driven casing seals well, preventing cross contamination	relatively slow minimum size diameter limited to 6 inches difficult to collect rock samples
Air rotary (with foam)	Consolidated or unconsolidated formations, no depth limitations	quick and efficient core samples easily collected	introduction of air to ground water may alter chemistry foam may interfere with organic and inorganic parameters (1) loss of circulation in fractured or high permeability zones potential to miss saturated zone
Bucket auger	Fine grained formations, Shallow (< 100 ft), large diameter wells, difficult in boulder environment	less well development is required less potential for cross contamination	disturbs large areas of the formation
Solid-stem continuous flight auger (generally not recommended)	Glaciated or unconsolidated materials (< 150 ft)		limited to unconsolidated fine grained materials drilling depth 150 ft. difficult to collect formation samples

Method	Environment	Advantages	Disadvantages
Reverse circulation rotary (generally not recommended)	Consolidated formations	formation sampling	limited applications uses large quantities of water
Mud rotary (generally not recommended)	Consolidated formations to any depth	fast drilling flowing artesian conditions can be managed.	mud and water circulated through borehole difficult to completely remove all mud mud may contain organic matter high potential for cross contamination may alter ground water chemistry may alter permeability

Notes:

(1) The effects of air injection would not be long-lived if the well is developed properly. Foams approved for potable water wells by the National Sanitation Foundation would not be problematic if used according to specifications.
(2) Not listed in order of preference.

7.7.3.1.2 Screened Interval

The depth and the length of the screen interval of a well should ensure that the samples will be obtained from the portion of the aquifer that will detect the earliest impacts of wastewater land treatment on ground water quality. For the majority of sites, this will be the uppermost portion of the uppermost aquifer.

This element of well construction is site specific, depending upon the contaminants of concern (typically nitrate, total dissolved solids (TDS), iron, manganese, and chloride) and the characteristics of the aquifer. Contaminants may be confined to narrow zones within an aquifer. Table 7-14 describes the advantages and disadvantages of both short and long well screens. In situations where it may not be sufficient to monitor all contaminants with a single well, multiple wells, or well clusters may be installed.

Table 7-14. Advantages and Disadvantages of Short and Long Well Screens.

Well Screen Type	Advantages (+) and Disadvantages (-)
Short well screens (2-5 feet)	+ Allow discrete sampling of the formation. targeting contaminants concentrated at specific depths. + Isolate a single flow zone. - Does not allow for substantial vertical dilution in the borehole. + Easier to detect increases in contaminant concentrations. - Not appropriate for long-term monitoring in aquifers with declining water levels.
Long well screens (10-20 feet)	+ Ideal for aquifers whose potentiometric surface fluctuates dramatically. + Allow sufficient quantities of water to enter the borehole in low-permeability aquifers.

Multiple wells installed with well screens at various depths are appropriate when the aquifer is heterogeneous, when the site geology is complex, when there are fractures or faults present, when multiple aquifers will be affected, when there is a perched aquifer, or when the aquifer is discontinuous, (EPA, 1986).

In areas with extreme water table fluctuations, more than one monitoring well may be needed, so that the water table can be adequately sampled. For example, in paired wells, the upper and lower screens should be 10 to 15 feet in length for the shallow and deep well respectively. The bottom of the upper screen of the shallow well should end where the top of the lower screen of the deeper well begins. All monitoring wells, particularly multiple wells, must be designed and installed to prevent cross contamination of aquifers.

A single well is usually sufficient if the aquifer is homogeneous, the geology is simple, and there are few contaminants. For most applications at wastewater land treatment facilities, the screened interval should be placed in the uppermost water-bearing zone. The length and positioning of the well screen below land surface must be such that the static water table is never above the uppermost or below the lowermost screen openings at any time of the year (Figure 7-6). Screen settings that do not meet this criteria result in either "dry" wells (i.e., the water table is below the screen, precluding collection of a sample) or a situation where the layer of dissolved contaminants in the groundwater may be above the zone where the sample is collected (i.e. the water table is above the uppermost screen openings). As a rule of thumb, monitoring wells should be screened in the top 10 to 15 feet of this uppermost water-bearing zone, with adequate screen above the water table to allow for seasonal water table fluctuations.

Well diameters are generally 2-inch or 4-inch, whichever is sufficient to accommodate the sampling pump. Two-inch or smaller casing material may be used for wells that are sampled using low-flow sampling methods. One problem with two-inch wells is that pump tests cannot be run. Four-inch wells are generally adequate to run pump tests.

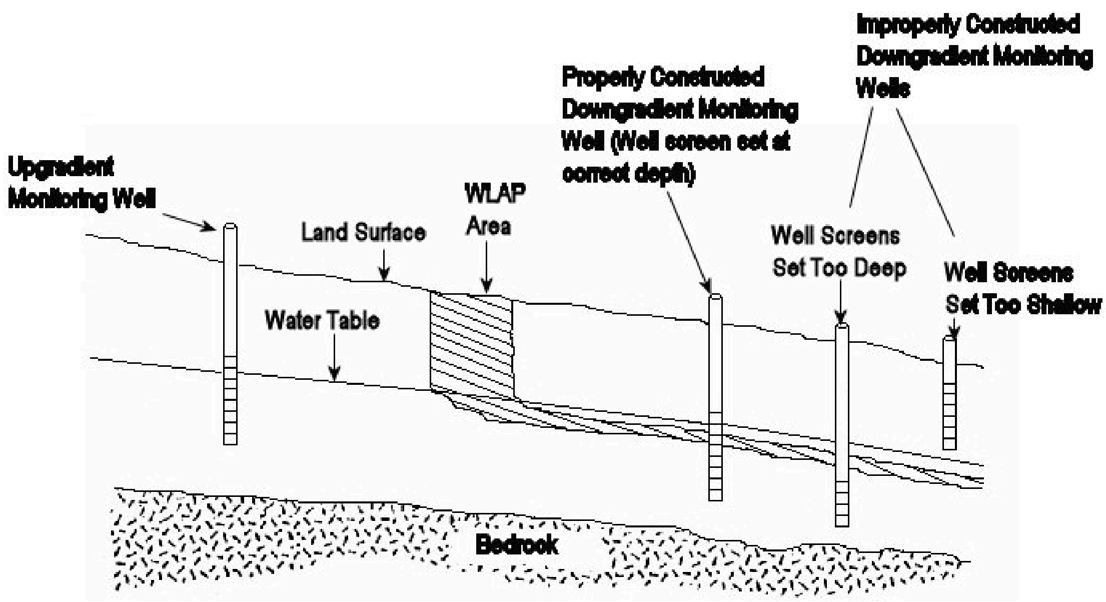


Figure 7-6. Proper and Improper Placement of Screens for Monitoring Wells.

The screen and sand pack material should be selected so that the well can be developed with minimal sediment production over the life of the well. Casing and screen material should be designed to last for the duration of the monitoring program. ASTM D 5092-90 may be used as a guide for selection of casing and screen material. Screen slot size should be determined relative to the interval to be monitored so that the well will produce sediment-free water for the life of the well. (See Driscoll (1986), page 395 and the following pages for further discussion.)

7.7.3.1.3 Casing Materials

A monitoring well is literally an intrusion of foreign material into the subsurface for investigative purposes. It is important to consider chemical reactions between any foreign matter introduced into the aquifer with water chemistry. Typically, care is given to assuring that the well casing and screen materials are compatible with the constituents, which may be present in ground water. Casing material should be selected based on the ground water chemistry to avoid corrosion or chemical degradation.

Additionally, the casing material can influence the water quality of the sample by either sorbing contaminants from ground water or leaching contaminants from the casing material into the ground water sample. Table 7-15 describes several types of casing material and the advantages and disadvantages as they are used in a ground water monitoring network:

- PVC (thermoplastic material) is recommended for inorganic samples. Threaded PVC casing and screen should be used, so that glues are not needed; the volatile and semi-volatile constituents in glues may contaminate samples in certain circumstances.
- Stainless steel is recommended for all ground waters, except acidic waters.
- PTFE (fluoropolymer material, i.e., Teflon®)[4] is excellent for all types of ground water and all types of chemical constituents.
- Mild steel is not advocated.

Table 7-15. Monitoring Well Casing Materials.

Casing Material	Suggested Use	Advantages	Disadvantages
PVC (thermoplastic materials) minimum schedule 40 recommended	Inorganic	lightweight inexpensive available resistant to acids and alkaloids	less rigid than steel may sorb or leach organic chemicals
Stainless steel 304 or 316 recommended	all ground water except acidic waters	strong rigid resistant to corrosion and oxidation available resistant to organic compounds	heavy expensive may corrode in acidic waters may leach Cr, Fe, Ni
PTFE (fluoropolymer materials - Teflon)	excellent for all types of ground waters and all types of chemical constituents	lightweight inert resistant to most chemicals good for corrosive environments	expensive not readily available
Mild steel not advocated	organic constituents, not recommended for corrosive conditions	strong rigid available	heavy may leach metals not chemically resistant

Other materials used or placed in the borehole should also be made of compatible materials. These materials include welding compounds, bentonite, sand pack materials, centralizers, packers, and grout. Everything placed in the aquifer must come into equilibrium with the

[4] Teflon® is a registered trademark of E. I. du Pont de Nemours and Company

water in the formation. This may mean contaminants may be precipitated onto the material or may be dissolved in ground water (Pennino, 1988). Ultimately, the presence of the monitoring well can alter the chemistry of the ground water, therefore care should be taken to minimize its impacts.

Knowledge of the water quality of the well, as it is being constructed, is highly desirable. Such knowledge can affect decisions regarding continued construction, modifications in construction, selection of materials, or in the planned operations of the completed well. Common problems related to well construction and water quality monitoring include water zones to be excluded by casing or grouting; selected casing perforation; choice of casing and screen material; and screen placement. Section 7.7.3.1.3 summarizes the applicability, advantages, and disadvantages of well casing materials.

7.7.3.1.4 Seals, Packing and Grouting

An adequate concrete surface seal, generally 3 feet thick, or more, should be provided around the outer protective casing to prevent migration of contaminants from the surface to the well screen. This surface seal should be sloped away from the well casing.

A sanitary seal should be placed above the filter pack. Bentonite chips or pellets are typically used to provide this seal. Grout (cement or bentonite) should be placed above the sanitary seal, up to where the surface seal will begin.

The sand pack should extend above the well screen to prevent entry of grout and/or bentonite into the screened interval. See Figure 7-7 and Figure 7-8, for general monitoring well design for ground water sample collection at wastewater land application sites and as-built construction details for monitoring well at wastewater land application sites respectively. DEQ (March 2001) has step-by-step instructions for monitoring well construction (Appendix B p 59-61) that should be consulted for specifics.

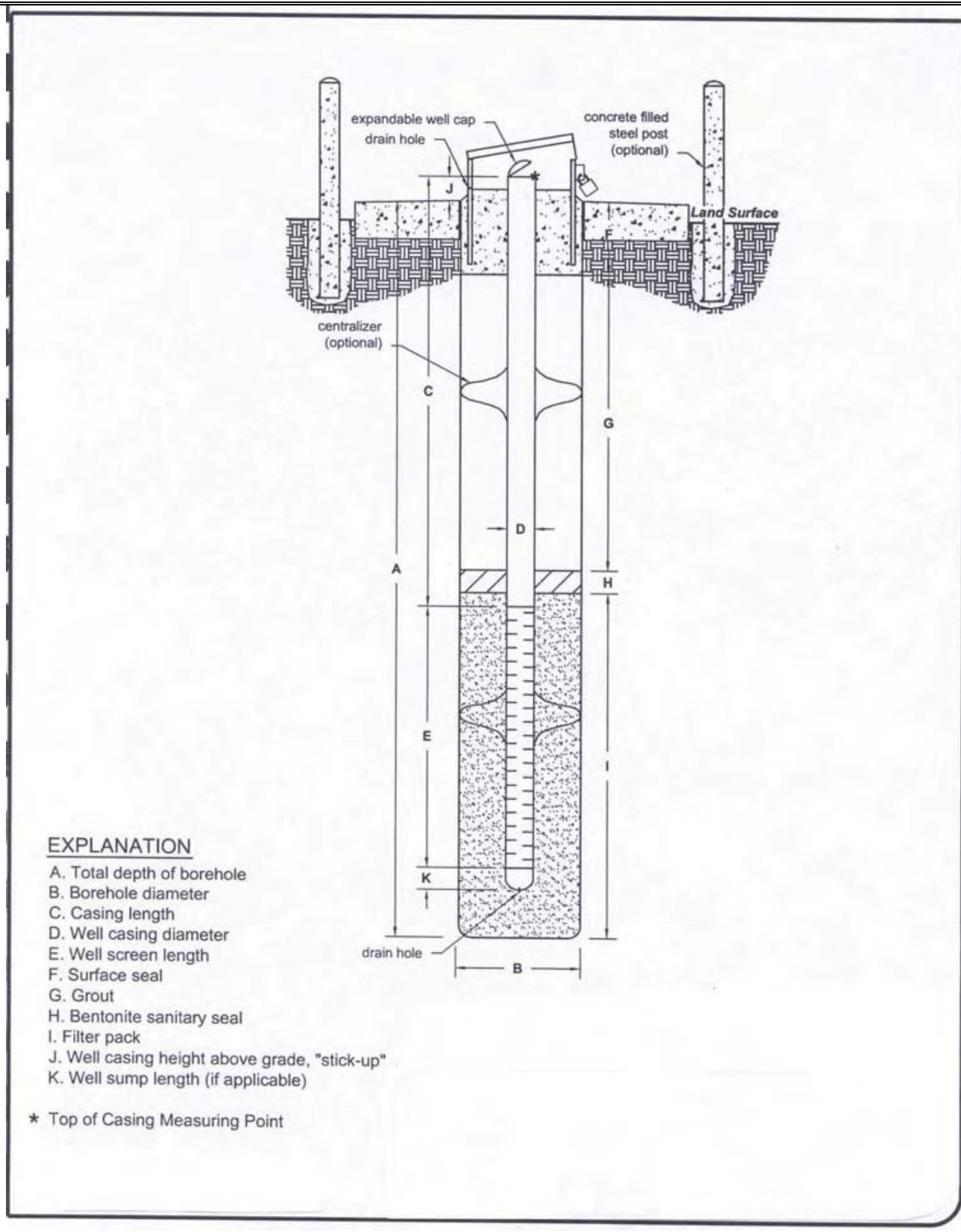
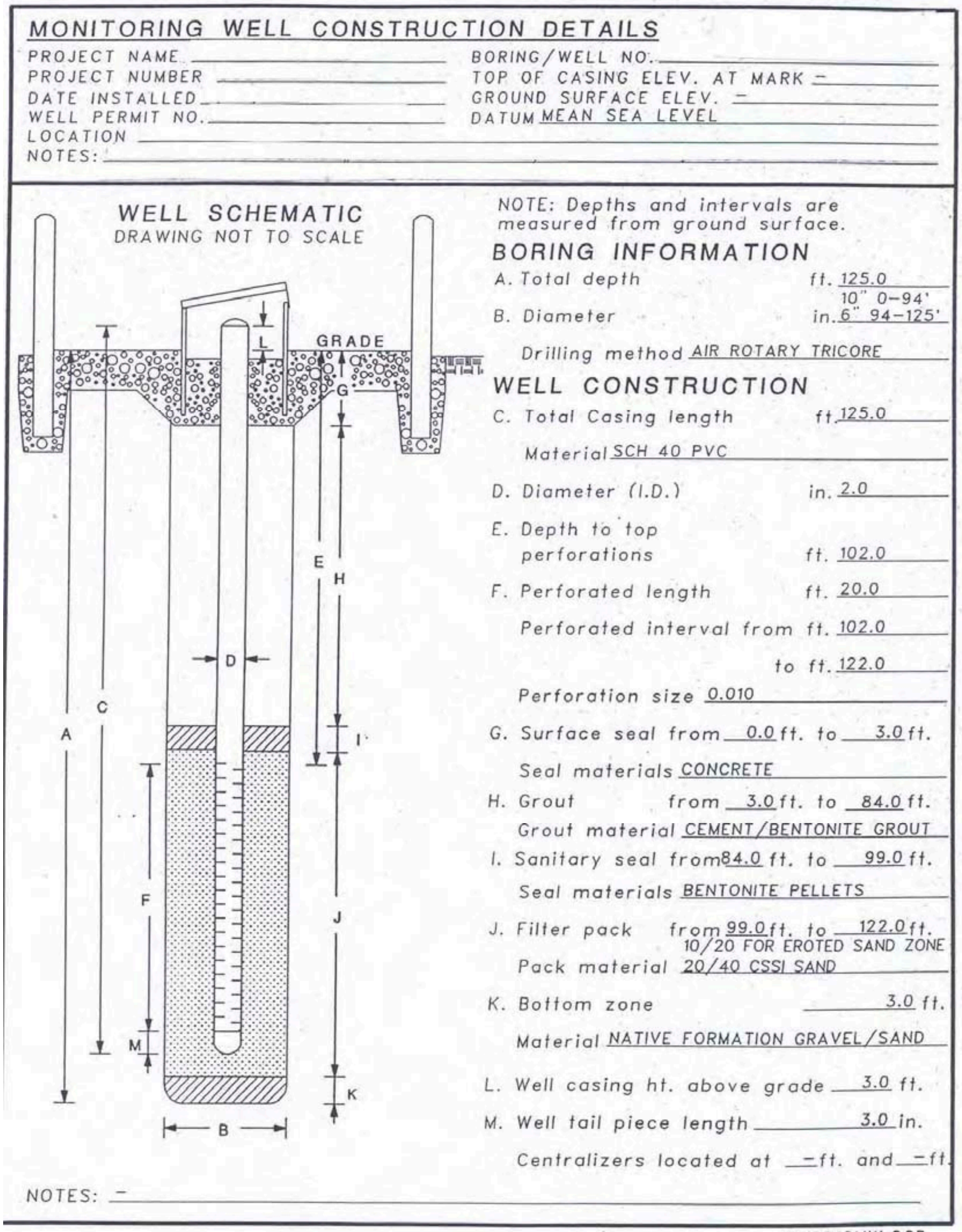


Figure 7-7. General monitoring well design for ground water sample collection at wastewater land application sites.[5]

5 Reproduced by permission of Cascade Earth Sciences.



MONITORING WELL CONSTRUCTION DETAILS

PROJECT NAME
PROJECT NUMBER
DATE INSTALLED
WELL PERMIT NO.
LOCATION
NOTES:

BORING/WELL NO.
TOP OF CASING ELEV. AT MARK –
GROUND SURFACE ELEV. –
DATUM MEAN SEA LEVEL

NOTE: Depths and intervals are measured from ground surface.

BORING INFORMATION

A. Total depth ft. 125.0
B. Diameter in. 10" 0–94' / 6" 94–125'
Drilling method AIR ROTARY TRICORE

WELL CONSTRUCTION

C. Total Casing length ft. 125.0
Material SCH 40 PVC
D. Diameter (I.D.) in. 2.0
E. Depth to top perforations ft. 102.0
F. Perforated length ft. 20.0
Perforated interval from ft. 102.0 to ft. 122.0
Perforation size 0.010
G. Surface seal from 0.0 ft. to 3.0 ft.
Seal materials CONCRETE
H. Grout from 3.0 ft. to 84.0 ft.
Grout material CEMENT/BENTONITE GROUT
I. Sanitary seal from 84.0 ft. to 99.0 ft.
Seal materials BENTONITE PELLETS
J. Filter pack from 99.0 ft. to 122.0 ft.
Pack material 20/40 CSSI SAND, 10/20 FOR EROTED SAND ZONE
K. Bottom zone 3.0 ft.
Material NATIVE FORMATION GRAVEL/SAND
L. Well casing ht. above grade 3.0 ft.
M. Well tail piece length 3.0 in.
Centralizers located at – ft. and – ft.

NOTES: –

Figure 7-8. As-built construction details for monitoring well at wastewater land application sites.[6]

[6] Reproduced by permission of Cascade Earth Sciences.

7.7.3.1.5 Monitoring Well Development

During drilling and monitoring well installation, fine sediment particles are forced through the sides of the borehole, which act to clog the formation. This reduces the hydraulic conductivity of the aquifer adjacent to the borehole. The fine materials must be removed from the well intake to assure representative ground water samples will be collected. If the particulate matter is not removed, water moving into the borehole will be turbid and will reduce the integrity of the water sample. Well development also repairs the damage inflicted on the formation during drilling.

All new wells must be developed prior to water quality compliance monitoring. A monitoring well is considered adequately developed when clean, non-turbid water can be removed from the formation. The time interval will vary depending upon the formation material and the amount of damage incurred during drilling. The goal in well development is to continue the process until the water is chemically stable (within 10% per casing volume) and the water is non-turbid.

It is important for the facility to properly develop the wells to assure the wells will yield representative samples. The investment of the monitoring well installation, sampling and analytical costs will not be wasted due to insufficient development time. The additional effort spent on well development will result in samples that are more representative of water chemistry in the formation being monitored.

Table 7-16 describes the common well development techniques. Puls and Powell, (1992), recommend using a water pump which is slowly raised and lowered throughout the length of the screened interval without causing excessive surging. Development techniques which introduce fluids or air into the formation are not recommended due to the possible alteration of ground water chemistry. Bailing, mechanical surging, overpumping and backwashing are all recommended well development techniques. A combination of methods is recommended to assure that adequate surging dislodges the particulates, and that the particulates are physically removed from the well. For wells that are purged using standard pumping methods, purge volumes should include the amount of water contained in the sand pack and inside the casing.

For each monitoring well installed, documentation should be provided for the development method, flow rate, the length of time, and the criteria used for ending the development procedures.

Table 7-16. Well Development Techniques

Method	Description	Advantages	Disadvantages
Bailer	Motion of introducing a bailer into the borehole causes a surge of water to be forced into the formation.	removes fines good for small diameter wells breaks up bridging in formation	not as effective as surge blocks must use sufficiently heavy bailer
Mechanical surging	A block the size of the inner diameter of the well is moved up and down throughout the screened interval. Must be used in conjunction with a bailer to remove fines.	effective at dislodging fines physically breaks up bridges and removes particulates from casing walls good for low yield formations	caution needed to avoid damage to screen and casing caution to prevent plugging screen with particulates may damage filter pack
Overpumping	Pumping at a rate that substantially exceeds the ability of the formation to deliver. The increased velocity causes migration of particles towards the pumping well. Typically used after bailing, or surging and bailing to avoid pump burnout caused by excess particulates in the well bore.	most common least expensive pump removes particulates effective when alternating pump on and off effective when raising and lowering the pump works best in coarse materials minimal time and effort no new fluids introduced	not as vigorous as backwashing can leave the lower portion of large screen intervals undeveloped
Backwashing	The surging action consists of lifting a column of water within the well and then letting it fall back into the well. Reversing the direction of flow breaks down the bridging and the particles are moved back into the well when the pump is restarted.	low cost breaks down bridging in filter pack no new fluids introduced	tends to push fine grained sediments into filter pack potential for air entrainment if air is used unless combined with pumping or bailing, does not remove fines possible disturbance to the gravel pack
Air surging	Air is injected into the well to lift the water to the surface, and then the water is allowed to fall back down the borehole.	develops discrete zones can be used to open fractures	can entrain air permanently into the formation alter the chemistry of the formation water can reduce the permeability
Jetting	Operation of a horizontal jet forces water inside the well screen openings.	develops discrete zones	can drive fines into the formation can alter the chemistry of the formation water can reduce the permeability

Note: A combination of these methods is recommended.

7.7.4 Ground Water Sampling

This section provides guidance on sampling supplies and equipment, well purging, sample collection, sample packing, and decontamination procedures. Guidance regarding documenting of a ground water sampling event can be found in ASTM D 6089 – 97 (2003).

7.7.4.1.1 Sampling Supplies and Equipment

Prior planning and careful preparation of field equipment before sampling will ensure good results from the laboratory. The following provides a list of supplies and equipment to be used when sampling ground water.

- disposable gloves
- documentation (forms, log books, and O&M manual, etc.)
- indelible ink pen
- well lock keys
- tape measure
- water level monitoring device and supplies (batteries, chalk and paste as needed)
- field parameter meters with calibration standards
- decontaminated sampling pump with proper tubing and power supply
- bailers with line
- sample bottles
- sample labels
- packing tape
- stop watch
- graduated cylinder
- filtration equipment
- cooler with cold packs or ice
- cleaning buckets and containers
- plastic garbage bags
- small sealable plastic bags
- plastic sheeting
- paper towels and hand soap
- cleaning brushes
- phosphate-free laboratory soap

- deionized organic-free water and hand sprayers
- high purity laboratory grade hexane, acetone, or isopropanol (all available from laboratory supply companies)

Customized kits for sample collection may be supplied by a contract laboratory. These kits include all the items needed for collection and shipment of samples. Those conducting the sampling event should follow laboratory instructions and read container labels. Care should be taken not to discard preservatives that may have already been added to some containers.

If a laboratory sampling kit is not used, those conducting the sampling event should use only new containers or sanitized reusable containers, supplied by a lab, of the appropriate types for the required parameters. Containers should be selected and prepared according to the contract laboratory's instructions. Sample containers should be labeled before sample collection and the type and amount of preservative required should be recorded on each sample label. All sampling equipment, such as bailers, containers, and tubing should be selected and thoroughly cleaned based on the parameters to be monitored. Disposable bailers of the appropriate composition may be used. Teflon™, stainless steel, or glass should be used when sampling for organics, such as solvents and petroleum product contamination. Do not use PVC or other plastics.

7.7.4.1.2 Well Purging

Stagnant water sitting in a well casing is exposed to the atmosphere which can alter the chemistry of the water. Improper well purging can result in gross errors to analytical results (Barcelona, 1989). Wells should be purged until a representative ground water sample can be collected. The exception to this is taking water level measurements, which must be taken *before the well is purged*. To measure static water level, do the following:

From a permanent reference at the top of the well casing, lower a clean weighted steel tape or electric sounder into the well.

15. Record the wet level mark on the tape and subtract it from the reference point to obtain the depth of water. (Use the same reference point each time a water level measurement is made at the well.)

Ground water monitoring wells should be purged for a minimum of three casing volumes and/or until field measurements stabilize. For pH, the following conditions should be met:

- two successive temperature values measured at least five minutes apart are within one degree Celsius of each other,
- pH values for two successive measurements, measured at least five minutes apart, are within 0.2 units of each other
- two successive specific conductance values, measured at least five minutes apart, are within 10% of each other

This procedure will determine when the wells are suitable for sampling for constituents required by the permit. Other procedures, such as low flow sampling, may be considered by DEQ for approval. DEQ (March 2001; Appendix B pp. 40-58) has standard operating procedures for monitoring well sampling and field parameter acquisition which should be consulted for specifics.

To calculate casing volume, use the following equation (from EPA, 1995 Section 8.0):

$$V_w = 7.48\pi \cdot r^2 h$$

Where:

V_w = well volume (gallons)

r = inside radius of the well (feet)

h = height of the water column (feet). Subtract depth to water from total depth of well

Note: 7.48 gal/ft^3 is the conversion factor to express V_w in gallons.

Stabilization of the field parameters especially dissolved oxygen provides assurance that the sample water is representative of aquifer conditions, without disturbing the flow patterns in the aquifer. Purging the well dry and sampling the next day after the well has recovered, is not advisable, since the water entering the borehole will be exposed to the atmosphere and will not be representative of the water in the formation. There are circumstances however, where this may be the only option.

Using low flow pumps for purging generally produces high quality representative samples. Low rate pumping is the preferred method for purging, because bailing may increase turbidity by stirring up sediment in the well. When purging with a pump, slowly lower the pump to just below the top of the standing water column. Continue lowering it as the water level drops and the stagnant water is removed. Barcelona (1989) recommends using low flow rates (0.2-0.3 liters/minute) during both purging and sampling. Purge rates should always be below the rate at which the well was developed. Purge water should be disposed of according to state and federal regulations.

If a pump is not available or cannot be used, use a bottom-emptying bailer to purge and collect samples. To purge using a bailer, lower the bailer slowly, to just below the water level, and retract slowly to reduce aeration and turbidity. Collect the purged water in a graduated bucket to measure a minimum of at least three well volumes, or as discussed above. Bailer lines of braided nylon or cotton cord must not be reused, even if clean, in order to avoid the probability of cross-contamination. Lines must consist of Teflon-coated wire, single strand stainless steel wire, or other monofilament line. Bailers should not be left in wells. Contamination can occur when they are handled outside the wells and placed back inside. Contamination can also occur as a result of deterioration of bailer lines.

7.7.4.1.3 Sample Collection

Proper sample collection is critical to acquiring reliable data which is representative of ground water conditions. Ground water quality samples should be submitted for analysis at a certified laboratory. Samples should be collected according to the laboratory's instructions regarding sample container, preservation, filtering, holding time, and collection procedures. It is standard procedure to follow chain of custody procedures with documentation of the location and handling of the sample from the time of collection until the time of analysis.

Sampling Equipment

It is important to consider the type of sampling equipment and the material of which it is constructed. Dedicated sampling equipment is preferred. Table 7-17 describes the most common and recommended pumps/bailers for ground water quality sampling.

Table 7-17. Ground Water Sampling Equipment

Equipment	Advantages	Disadvantages
Positive Displacement Pump (bladder pump)	Efficient well purging maintains integrity of sample easy to use high quality, consistent, representative samples does not introduce air low flow rates	difficult to decontaminate if the pump and/or tubing is not dedicated limited to depths of < 100 ft (DB says 100's of ft possible) lengthy purge process
Submersible electric pump	efficient purging tool portable variable pump rate reliable	potential for affects on trace organic constituents expensive power source required
Suction Pump (peristaltic pump)	portable, inexpensive, readily available, efficient for purging, not recommended for sampling	useful to depths < 25 ft may cause pH modifications, vacuum can cause loss of dissolved gases and volatile organic constituents silicon tubing has high sorption capacity for organic constituents
Bailer	Inexpensive, portable, no power source, easy to decontaminate	transfer of sample may cause aeration, potential for introducing contamination is high, unsuitable for well purging caution with operation and sample handling time consuming labor intensive
Waterra Inertial Lift Pump	Dedicated Variable flow rates Reliable Simple to Operate Inexpensive tubing and foot valves Manual, electrical power and gas-powered options available	Care must be taken to minimize excessive formation surging Limited to depths of 250 feet.

Note: Methods are listed in order of preference.

Low flow pumps (0.2-0.3 liters/minute) such as the bladder pump, reduce the introduction of oxygen into the sample, which can alter the water chemistry. These pumps also cause the least amount of disturbance to the water in the well and as such are the preferred sampling device. Bailers are not recommended since they disrupt the column of water and re-suspend sediment. Studies show that higher concentrations of metals are detected, mistakenly, in samples collected with bailers, than from samples collected with low flow rates using a peristaltic pump (Puls and Powell, 1992). Ideally the proper sampling equipment which creates the least disturbance to the water in the borehole and formation will yield water quality samples which are representative of true aquifer conditions. Other considerations during sampling include the placement of the intake valve on the pump in order to create the minimum disturbance to the stagnant water above and below the screened interval.

Sampling equipment should be made of inert materials to assure that the sample will not be contaminated during the sample collection process. Table 7-18 describes the recommended material for pumps and bailers based on the type of constituents being analyzed. Teflon is the best inert material for the majority of constituents, and stainless steel is the second choice, (Garner, 1988).

Table 7-18. Sampling Equipment Material.

Material	Advantages	Disadvantages
PTFE (fluoropolymer materials, Teflon)	recommended for organic constituents recommended for corrosive situations where organic constituents are of interest recommended for metals easiest to clean inert east likely to introduce sample bias or imprecision	expensive
Stainless Steel	recommended for organic constituents	may corrode in acidic waters corrosion products may introduce Fe, Cr, Ni expensive
PVC (thermoplastic materials)	lightweight inexpensive resistant to acids recommended for inorganic constituents	not recommended for organic constituents (may sorb or leach) may release Sn or Sb compounds
Mild Steel (low carbon steel, galvanized steel, carbon steel)	readily available	corrosion products Fe, Mn (galvanized Zn, Cd) active adsorption sites for organic constituents and inorganics not recommended for organic constituents not recommended for corrosive conditions

Note: Materials are listed in order of preference.

Ground water samples should be filtered (if necessary), preserved and analyzed in the field as soon as possible after collection to avoid equilibrium changes due to volatilization, sorption, leaching, or degassing, (Barcelona, 1985). Only ground water samples collected for metal or ionic analysis should be filtered. Samples collected for analysis of organic compounds should never be filtered. Traditional filtration protocols for inorganic parameters recommend using an in-line filter with a 0.45 micron pore size. This is also consistent with the *National Pollutant Discharge Elimination System* (NPDES) guidance for metals filtration. Puls and Powell (1992) noted that larger diameter, high capacity filters erroneously produced lower concentrations of contaminants on a routine basis; therefore, they are not recommended.

Sample Collection with Pumps

Low flow pumps (0.2-0.3 liters/minute) such as the bladder pump, reduce the introduction of oxygen into the sample, which can alter the water chemistry. These pumps also cause the least amount of disturbance to the water in the well and as such are the preferred sampling device. When sampling with a portable pump, do the following:

Have sample containers ready before turning on the pump.

16. Lower the pump, slowly, to the desired depth in the well. The placement of the intake valve on the pump should be considered during sampling in order to create the minimum disturbance to the stagnant water above and below the screened interval.
17. Adjust the flow rate to less than 100 mL per minute to reduce agitation.
18. Decontaminate the pump before moving to the next well (see 7.7.4.2).

Sample Collection with Bailers

Bailers are not recommended because they disrupt the column of water and re-suspend sediment. Studies show that higher concentrations of metals are detected, mistakenly, in samples collected with bailers, than from samples collected with low flow rates using a peristaltic pump (Puls and Powell, 1992). But if it is necessary to sample with a bailer, do the following:

Lower the bailer slowly into the well, avoiding agitation, and allow it to fill.

19. Retract the bailer slowly, and discharge the sample carefully into the container until the correct volume has been collected.
20. Add preservative if required, cap the container, and mix according to laboratory instructions. Take precautions to minimize turbidity and sediment in samples. This will minimize the need for filtering.
21. Use purging and sampling techniques previously described to minimize turbidity and agitation of sediment in wells.

In low-yielding wells and those containing high levels of suspended solids, slowly lower a bailer to the lowest standing water level and allow the water to flow into it. Carefully lift the bailer out of the well without allowing it to scrape or bang against the well casing. Allowing the well to recover into the bailer should produce a cleaner sample.

Minimizing Risk of Contamination

There are several ways to minimize risk of contamination during sampling:

- ensuring that all sampling equipment (bailers, tubing, containers, etc.) has been thoroughly cleaned and selected based on compatibility with parameters to be monitored
- using Teflon, stainless steel, or glass when sampling for organics; do not use PVC or other plastics
- using Teflon or glass when sampling for trace metals
- using new sample containers when sampling for compliance monitoring; do not reuse containers
- keeping containers closed before filling, and do not touch the inside of containers or caps
- wearing a new pair of disposable gloves or decontaminated reusable gloves for each sampling site
- placing new plastic sheeting on the ground near each well to hold the sampling equipment; do not step on the sheeting
- placing small samples that require cooling, such as volatile organics, in sealable plastic bags immediately after collection and before submerging in ice
- not smoking while collecting or handling samples, because volatile residues in the smoke can cause sample contamination

- not leaving your vehicle running near the sample collection area, to prevent contamination from engine exhaust fumes
- when using a pump, setting up the generator about 15 feet away and downwind from the well; performing all generator maintenance and fueling off-site and away from samples
- avoiding unnecessary handling of samples
- if dedicated monitoring systems (those permanently installed in wells) are **not** used, cleaning equipment to be reused thoroughly before sampling each well to minimize the risk of cross contamination; bailers left in wells are **not** dedicated systems
- taking enough pre-cleaned equipment to the field to sample each well, so that cleaning between wells is unnecessary; if field cleaning is necessary, an equipment blank may be used to make sure that no contamination results

Blanks should be used to check for contamination. Blanks consist of organic-free deionized water, which must be obtained from laboratories. Types of blanks include the following:

- a *trip blank* (a sealed container of organic-free, deionized water that must be taken to the field and sent back to the lab, unopened, with the samples); include at least one trip blank per cooler for volatiles to check for sample contamination during transportation.
- a *field blank* consists of organic-free deionized water taken to the field and handled in the same manner as the samples to check for contamination from handling, from added preservatives, or from airborne contaminants at the site, which are not from the waste being disposed of at the treatment facility.
- an *equipment blank* (organic-free deionized water, which is passed through the cleaned sampling equipment with added preservatives) may be used to detect any contamination from equipment used for more than one well.

General Procedures for Packing Samples

The following should be done when packing samples prior to shipment by courier or by personal transport to the laboratory:

Line a clean cooler with a large, heavy duty plastic bag, and add bags of ice.

22. Place the properly tagged samples in individual, sealable plastic bags, and seal the bags with chain-of-custody tape to ensure sample integrity.
23. Place bagged samples in the cooler, arranging bags of ice between samples to help prevent breakage; add sufficient ice to maintain the temperature of at 4o C (39.2o F) while the samples are in transit.
24. Enclose the appropriate forms in a sealable plastic bag, place with samples in the chest, and seal the large bag with chain of custody tape.
25. Minimize transport time, and ensure that samples will reach the laboratory without being exposed to temperature variations and without exceeding holding times.

Once the laboratory has completed the sample analysis, a report containing the analytical results will be sent to the person requesting the analysis. Monitoring forms should be carefully filled out, making sure that all information is included and that the data transferred from laboratory reports are recorded in the correct concentration units. Complete identification information, such as permit number and facility, or permit name, should be included on all correspondence and additional laboratory reports. Forms and laboratory reports should be submitted on time. It is vitally important that the procedures demonstrated be followed carefully by the sampler to avoid costly resampling and to ensure that any ground water contamination is appropriately characterized in the event remediation is necessary.

A facility that utilizes a contractor for ground water sampling should still be familiar with the sampling frequencies and parameters and the general requirements of the sampling protocol. If there are any questions regarding facility specific monitoring requirements, DEQ regional office personnel should be contacted.

7.7.4.2 Decontamination

All sampling equipment that is not dedicated should be routinely decontaminated prior to collecting a sample. Portable sampling systems are used more frequently than dedicated systems because of lower costs. However, because portable systems require using the same equipment from well to well, they increase the possibility of cross contamination unless strict cleaning procedures are followed.

Decontamination between each sampling point eliminates the possibility of cross-contamination, which could introduce a level of error into the sampling results. Decontamination typically involves removing or neutralizing contaminants that have accumulated on the surface of the sampling equipment. Care should be taken not to use cleaning solutions which contain a contaminant of concern. Decontamination should be conducted according to appropriate sampling procedures. Cleaning procedures must be selected based on the equipment composition and the parameters to be monitored.

The following is a summary of minimum cleaning techniques for bailers, applicable for other equipment of the same composition. For stainless steel bailers and equipment, use the following:

- phosphate-free soap and hot tap water wash
- hot tap water rinse
- deionized water rinse
- isopropyl alcohol rinse
- deionized water rinse
- air dry
- Wrap the bailer with aluminum foil or other material to prevent contamination before use. Consider target contaminants when selecting a wrap material.
- To clean Teflon or glass bailers and equipment use the following:
- phosphate-free soap and hot tap water wash
- hot tap water rinse

- ten percent nitric acid rinse
- deionized water rinse
- isopropyl alcohol rinse
- deionized water rinse
- air dry

Wrap to prevent contamination before use. Again, consider the target contaminants when selecting wrapping material.

7.7.4.3 Analysis and Methods

Table 7-19. Common Ground Water Analytes and Methods

Parameter	Abbreviations	Units	EPA[1]	Standard Methods[2]	Reportable Detection Limits[4,5]
Alkalinity	Alk	mg/L	310.1 or 310.2	2320	<1.0 mg/L
pH	pH	S.U.	150.1	4500-H+	> 1, <12
Specific Conductance	SC	umhos/cm	120.1	2510 B	<2 umhos/cm
Total Dissolved Solids (inorganic)	TDS	mg/L	160.2	2540 C	<1.0 mg/L
Static Water Level	SWL	feet	NA[6]	steel tape, electric tape or other	<0.01 ft
Chemical Oxygen Demand	COD	mg/L	410.2	5220 B	>5.0 mg/L
Nitrate-N	NO3-N	mg/L	352.1	4500-NO3	<0.1 mg/L
Nitrate-N	NO3-N	mg/L	353.2	4500-NO3	< 0.005 mg/L
Total Kjeldahl Nitrogen	TKN-N	mg/L	351.1, 351.2, 351.3 or 351.4	4500-Norg	<0.1 mg/L
Iron, Total Unfiltered	Fe	mg/L	236.1	3500-Fe	<.01 mg/L
Manganese, Total Unfiltered	Mn	mg/L	200.7	3500-Mn	<.001 mg/L
Manganese, Total Unfiltered	Mn	mg/L	243.1	3500-Mn	<.01 mg/L
Sodium	Na	mg/L	273.1	3500-Na	<0.1 mg/L
Potassium	K	mg/L	258.1	3500-K	<0.1 mg/L
Chloride	Cl	mg/L	325.1, 325.2, or 325.3	4500-Cl	<0.9 mg/L
Calcium	Ca	mg/L	215.1 or 215.2	3500-Ca	<0.1 mg/L
Total Organic Carbon	TOC	mg/L		5310 B 1 mg/L	1 mg/L
Total Organic Carbon	TOC	mg/L		5310 C < 1 mg/L	0.05 mg/L
Total Organic Carbon	TOC	mg/L		5310 D < 1 mg/L	0.01 mg/L
Magnesium	Mg	mg/L	242.1	3500-Mg	<0.1 mg/L
Fluoride	F	mg/L	340.1, 340.2, or 340.3	4500-F	<0.1 mg/L
Gross Alpha	A	pCi/l	-	7110	NA
Gross Beta	B	pCi/l	-	7110	NA

Parameter	Abbreviations	Units	EPA[1]	Standard Methods[2]	Reportable Detection Limits[4,5]
Ammonia	NH3	mg/L	350.1, 350.2, or 350.3	4500-NH3	<0.005 mg/L
Phosphorus Total	P	mg/L	365.4	4500-P	<0.005 mg/L
Dissolved Oxygen	DO	mg/L	360.1 or 360.2	4500-O	<0.1 mg/L
Sulfate	SO4	mg/L	300.0	4500-SO4-2	<2.0 mg/L
Sulfate	SO4	mg/L	375.1, 375.2, or 375.3	4500-SO4-2	<2.5 mg/L
Total Coliform	TC	#/100 ml	p.1143 or p.1083	9221 B 9222 B	NA
Fecal Coliform	FC	#/100 ml	p.1323 or p.1243	9221 C 9222 D	NA
Fecal Streptococcus	FS	#/100 ml	p.1393, p.1363, or p.1433	9230 B 9230 C	NA

Notes:
1. Methods for Chemical Analysis of Water and Wastes. Environmental Protection Agency, Environmental Monitoring Systems Laboratory-Cincinnati (EMSL-Cllll), EPA-600/4-79-020. Revised March 1983 and 1979, where applicable.
2. Greenberg, A.E. et al. (eds). 1992. Standard Methods for the Examination of Water and Wastewater - 18th Edition.
3. Bordner, R.H., and J.A. Winter, eds. 1978. "Microbiological Methods for Monitoring the Environment, Water and Waste." Environmental Monitoring Systems Laboratory, U.S. Environmental Protection Agency. EPA-600/8-78-017.
4. Reportable detection limits used by IDHW-Bureau of Laboratories as of December, 2005.
5. Estimated Method Detection Limit (MDL) achievable by specific analytical method. For EPA methods, use the EPA methods or Environmental Methods Monitoring Index (EMMI) or for Standard Methods use the latest edition of Standard Methods for the Examination of Water & Wastewater.
6. See Sections 4.1.1 through 4.1.10 in EPA (1993).

7.7.5 Soil-Water (Vadose) Monitoring Supplemental Information

7.7.5.1 Analytical Methods

Table 7-20. Common Soil Water Analytes and Methods.

Parameter	Abbreviations	Units	EPA[1]	Standard Methods[2]	Reportable Detection Limits[4,5]
Alkalinity	Alk	mg/L	310.1 or 310.2	2320	<1.0 mg/L
pH	pH	S.U.	150.1	4500-H+	> 1, < 12
Specific Conductance	SC	umhos/cm	120.1	2510 B	<2 umhos/cm
Total Dissolved Solids (inorganic)	TDS	mg/L	160.2	2540 C	<1.0 mg/L
Chemical Oxygen Demand	COD	mg/L	410.2	5220 B	>5.0 mg/L
Nitrate-N	NO3-N	mg/L	352.1	4500-NO3	<0.1 mg/L
Nitrate-N	NO3-N	mg/L	353.2	4500-NO3	<0.005 mg/L
Total Kjeldahl Nitrogen	TKN-N	mg/L	351.1, 351.2, 351.3 or 351.4	4500-Norg	<0.1 mg/L
Iron, Total Unfiltered	Fe	mg/L	236.1	3500-Fe	<.01 mg/L
Manganese, Total Unfiltered	Mn	mg/L	200.7	3500-Mn	<.001 mg/L
Manganese, Total Unfiltered	Mn	mg/L	243.1	3500-Mn	<.01 mg/L
Sodium	Na	mg/L	273.1	3500-Na	<0.1 mg/L
Potassium	K	mg/L	258.1	3500-K	<0.1 mg/L
Chloride	Cl	mg/L	325.1, 325.2, or 325.3	4500-Cl	<0.9 mg/L
Calcium	Ca	mg/L	215.1 or 215.2	3500-Ca	<0.1 mg/L
Total Organic Carbon	TOC	mg/L		5310 B 1 mg/L	1 mg/L
Total Organic Carbon	TOC	mg/L		5310 C < 1 mg/L	0.05 mg/L
Total Organic Carbon	TOC	mg/L		5310 D < 1 mg/L	0.01 mg/L
Magnesium	Mg	mg/L	242.1	3500-Mg	<0.1 mg/L
Fluoride	F	mg/L	340.1, 340.2, or 340.3	4500-F	<0.1 mg/L
Gross Alpha	A	pCi/l	-	7110	NA
Gross Beta	B	pCi/l	-	7110	NA
Ammonia	NH3	mg/L	350.1, 350.2, or 350.3	4500-NH3	<0.005 mg/L
Phosphorus Total	P	mg/L	365.4	4500-P	<0.005 mg/L
Dissolved Oxygen	DO	mg/L	360.1 or 360.2	4500-O	<0.1 mg/L

Parameter	Abbreviations	Units	EPA[1]	Standard Methods[2]	Reportable Detection Limits[4,5]
Sulfate	SO4	mg/L	300.0	4500-SO4-2	<2.0 mg/L
Sulfate	SO4	mg/L	375.1, 375.2, or 375.3	4500-SO4-2	<2.5 mg/L

Notes:
1. Methods for Chemical Analysis of Water and Wastes. Environmental Protection Agency, Environmental Monitoring Systems Laboratory-Cincinnati (EMSL-Cllll), EPA-600/4-79-020. Revised March 1983 and 1979 where applicable.
2. Greenberg, A.E. et al. (eds). 1992. Standard Methods for the Examination of Water and Wastewater - 18th Edition.
3. Bordner, R.H., and J.A. Winter, eds. 1978. "Microbiological Methods for Monitoring the Environment, Water and Waste." Environmental Monitoring Systems Laboratory, U.S. Environmental Protection Agency. EPA-600/8-78-017.
4. Reportable detection limits used by IDHW-Bureau of Laboratories as of December 2005.
5. Estimated Method Detection Limit (MDL) achievable by specific analytical method. For EPA methods, use the EPA methods or Environmental Methods Monitoring Index (EMMI) or for Standard Methods use the latest edition of Standard Methods for the Examination of Water & Wastewater.

7.7.5.2 Data Use and Interpretation

The following guidelines provide the framework to interpret lysimeter data. These guidelines, along with criteria which can be included in permits – such as acceptable ground water constituent concentration at a facility down gradient boundary and acceptable modeled percolate constituent concentration - will aid in determining whether wastewater land treatment management strategies have been effective or require modification.

Due to the potential variability within a site, results from respective sampling events from all lysimeters can be averaged – or a median utilized - to estimate the quality of percolate losses. Acreage weighting of lysimeter results – in proportion to the amount of acreage of a field a particular lysimeter represents - can serve to render the data more spatially representative.

Soil-water percolate is collected from the vadose zone and is not yet considered ground water. Therefore, water quality standards are not directly applicable. However, soil-water percolate can be used for system compliance with some knowledge of the aquifer. By using appropriate values for the properties of the aquifer, impacts to ground water can be estimated based on the quality and quantity of percolate losses. Thresholds of percolate quality and quantity can then be determined which would lead to exceedances of water quality standards, and such thresholds can be used in lieu of ground water limits, whether standards stipulated in regulation or site specific limits determined by DEQ.

7.7.5.2.1 Mass Flux Calculations

Mass flux is the mass of a constituent (NO_3-N in this example) that is percolating below the crop root zone into the underlying aquifer. (See EPA (1993) Section 9.5.1 for solute flux calculation methods; and Section 7.7.5 for methods to estimate soil water flux.)

To calculate a mass flux, both the volume and concentration of the soil-water percolate are needed. If pan lysimeters are used, both volume and concentration of macropore flow (which is not the only component of flow) are presumably already known. If pressure-vacuum samplers are used, the concentration of soil water at the extracting tension is known, but the soil-water percolate volume must be determined by another method (water balance, modeling, soil-moisture status, etc.).

While vadose zone monitoring has potential to answer questions about load to groundwater, instrumentation may not be reliable enough to measure concentration and flow to be used for estimating potential ground water impacts and compliance with trigger percolate concentration/flow limits in permits. The following discussion and example is presented to outline in concept how lysimeter data could be used notwithstanding its present limitations.

Mass flux should be determined over a period of time and not from one sampling event. A wastewater land treatment example, using data from a pressure-vacuum sampler and soil-water percolate volume calculated using a water balance method, is presented below.

Table 7-20 summarizes example nitrate nitrogen (NO_3-N) lysimeter data. The example land application field has five lysimeters and is sampled quarterly. The evaluation period (EP) for lysimeter data is nine (9) quarters, or 2.25 years, in this example.

Mass flux can only be calculated where there are soil-water percolate losses. Mass flux can be calculated on a pounds per acre (lbs/ac) basis using:

$$M = 0.227 * C_p * Q_p$$

Equation 7-3. Mass flux calculation.

Where:

M = mass flux (lb/ac)

C_p = percolate constituent concentration (mg/L)

Q_p = percolate flow (inch/ac)

MG = million gallons

Note: the factor 0.227 = 0.0272 MG/inch * 8.34 (lb/MG)/(1 mg/L)

For example, first quarter mass losses would be:

$$M = 0.227 * 27.01 \ mg/L * 3.2 \ in/ac = 19.6 \ lb/ac$$

Table 7-21. Quarterly Gravity Lysimeter Monitoring Data for Nitrate-Nitrogen.

Quarter	Month	Soil Water Nitrate-Nitrogen Data: Lysimeters no. 1 - 5 1	2	3	4	5	Column I Average Conc mg/L	Column II Estimated Percolate Volume inches	Column III Mass Loss lb/acre
		--- mg/L ---							
I	January							1.50	
	February							0.70	
	March		48.3	24.5		8.23	27.01	1.00	19.57
II	April							0.27	
	May							0.24	
	June		0.5	0.3	0.1	0.1	0.25	0.21	0.04
III	July							0.24	
	August							0.23	
	September	16.8	31.4	125.1	48	42	52.66	0.23	8.29
IV	October							0.24	
	November							1.04	
	December	9.92	2.57		15.68	3.13	7.83	1.89	5.62
V	January							1.38	
	February							0.85	
	March	14.55	5.1		11.23	17.9	12.20	1.04	9.03
VI	April							0.30	
	May							0.22	
	June	0.2		0.1	0.1	0.1	0.13	0.21	0.02
VII	July							0.20	
	August							0.19	
	September	53.3	37.4	78	82	56.8	61.50	0.23	8.59
VIII	October							0.20	
	November							1.11	
	December	8.88		0.67	9.22	3.3	5.52	2.01	4.15
IX	January							1.42	
	February							0.90	
	March	31.02	22.2	18.9	16.5	28.99	23.52	0.99	17.63
			Total Percolate Volume (inches/acre) ---->					19.03	
			Total Nitrate Nitrogen Mass Loss (lb/acre) ------------->						72.95
			Average Nitrate Nitrogen Concentration (mg/L) ------->						16.93

Notes: Column III = (Column I) * (sum of percolate volumes in Column II for the Quarter) * (0.2265)

7.7.5.2.2 Estimation of Ground Water Impact

The potential impact to the underlying ground water can be estimated using constituent mass flux information from lysimeter sampling and basic aquifer characteristics. One important simplifying assumption made here is that there is no sorption, denitrification, precipitation or other constituent losses or sequestration between the bottom of the crop root zone and ground water. All of these treatment processes are possible, which makes this assumption conservative.

Continuing with the same example, the potential ground water impacts at the down gradient boundary of the source area can be estimated using the EPA aquifer-mixing model (EPA, 1981).

$$C_{mix} = \frac{C_p Q_p + C_{gw} Q_{gw}}{Q_p + Q_{gw}}$$

Equation 7-4. EPA aquifer-mixing equation .

Where:

C_{mix} = constituent concentration in percolate and ground water mixture.

C_p = constituent concentration in percolate.

Q_p = percolate flow.

C_{gw} = constituent concentration in up gradient ground water.

Q_{gw} = ground water flow (volume/time).

Q_{gw} is calculated as shown:

$$Q_{gw} = kiA$$

Equation 7-5. Calculation of ground water flow, (Q_{gw}).

Where:

k = hydraulic conductivity (in ft/day)

i = gradient (ft/ft)

A = cross sectional area of down gradient boundary perpendicular to ground water flow, and is calculated by:

$$A = L * d$$

Equation 7-6. Calculation of down gradient cross sectional area perpendicular to ground water flow (A).

Where:

L = the length of the down gradient boundary perpendicular to ground water flow

d = the depth of the mixing zone. (special note: do depth calculations in metric units (meters), then convert to feet for remainder of the mixing zone calculations. This is calculated by:

$$d = d_{\alpha v} + d_{lv}$$

Equation 7-7. Calculation of ground water mixing zone depth (d).
(Source: eq. 44, page 45. EPA/540/R-95/128 May 1996. Soil Screening Guidance: Technical Background Document)

Where:

$d_{\alpha v}$ = depth of mixing due to vertical dispersivity, or

$$d_{\alpha v} = (2\alpha_v L)^{0.5}$$

d_{Iv} = depth of mixing due to downward velocity of infiltrating water (Source: eq. 38, page 44. EPA/540/R-95/128 May 1996. Soil Screening Guidance: Technical Background Document)

$$d_{Iv} = d_a\{1 - \exp[(-LI)/(V_s n_e d_a)]\}$$

Where:

α_v = vertical dispersivity (m)

$$a_v = 0.01\alpha_L$$

α_L = longitudinal dispersivity

$$\alpha_L = 0.82(\log_{10} L)^{2.446}$$

(Source: eq. 14b, page 907. Xu, M. and Eckstein, Y. 1995. Ground Water Vol. 33, No. 6; as corrected by Al-Suwaiyan, M.S., 1996, Ground Water Vol. 34 No. 4, page 578.)

Where:

L = length of source parallel to GW flow (meters)
n_e = effective aquifer porosity
d_a = aquifer depth (meters)
I = leachate infiltration rate (meters/yr)
V_s = ground water seepage velocity; (meters/year)

$$V_s = {}^{Ki}\!/_{n_e}$$

For this example, we are given the following:

For mixing zone depth calculations:

L = 2087 ft or 636.3 m
n_e = 0.30
d_a = 30 meters
I = 19.03 in/EP * 1 EP/2.25 yr * 1 ft/12 in * 1 m/3.28 ft = 0.218 m/yr
(note EP = evaluation period = 2.25 years in this example)
$\alpha_L = 0.82(\log_{10} 636.3\text{ m})^{2.446} = 10.2$
α_v = 0.102
k = 100 ft/day;
i = 0.0015 ft/ft (7.92 ft/mile); and
$V_s = ki/n_e$ = (100 ft/day)*(0.0015 ft/ft)/0.3 * 365 day/yr * 3.28 m/ft = 55.6 m/yr

$d_{Iv} = 30*\{1 - \exp[(-(636.3 * 0.218))/(55.6 * 0.3 * 30)]\} = 7.2$

$d_{\alpha v} = (2 * 0.102 * 636.3)^{0.5} = 11.4$

d = 11.4 + 7.2 = 18.2 meters or 61 ft

Site dimensions: square site of 100 acres (2087 ft by 2087 ft).

In our example,

Q_{gw} = kiA =(100 ft/day)*(0.0015 ft/ft)*(61 ft)*(2087 ft)

= 19096 ft^3/day, or

= (19096 ft^3/day)*(365 days/year)*(1 acre-ft/43,560 ft^3)

= 160 acre-ft/year discharging from the down gradient boundary,

or, for the volume during the evaluation period (EP)

= 160 acre-ft/yr * 2.25 yr/EP = 360 ac-ft/EP

Q_p is 19.03 in/EP (from Table 7-21). Converting to acre-feet we have:

Q_p = (19.03 in/[EP acre-year])*(100 acres)*(1 acre-feet/12 acre-inches)

Q_p = 158.6 acre-ft/EP

C_p = 16.93 mg/L (from Table 7-21).

C_{gw} = 3 mg/L

Putting these values into the EPA mixing zone equation introduced above we have:

$$C_{mix} = \frac{(16.93 \text{ mg/L})*(158.6 \text{ ac-ft/EP}) + (3.0 \text{ mg/L})*(360 \text{ ac-ft/EP})}{158.6 \text{ ac-ft/EP} + 360 \text{ ac-ft/EP}}$$

Solving for C_{mix}, the units acre-ft/year cancel to give units of mg/L, or

C_{mix} = 7.26 mg/L

The final ground water NO_3-N concentration is estimated to be 7.26 mg/L when the system achieves steady state conditions (which may or may not occur within the evaluation period). This result indicates that while the ground water standard for nitrate will not be exceeded, it does indicate the ground water concentration for nitrate-nitrogen is estimated to increase from 3.0 mg/L to 7.26 mg/L. Although most of the quarterly lysimeter samples exceeded the Maximum Contaminant Level, the ground water standard was not modeled to exceed the ground water standard. Beneficial uses may or may not be impacted, depending upon this modeled change in ground water quality is determined significant by DEQ in the site-specific circumstances.

As discussed at the beginning of 7.3, a maximum percolate constituent concentration (given a constant percolation rate) that will comply with site specific permit conditions can be determined. For example, if a down gradient ground water concentration limit (Cmix) is set at 10 mg/L at the down gradient boundary of the source area, and retaining other values assumed above, we can utilize the mixing zone equation and solve for percolate concentration (Cp).

$$C_p = \frac{\left\lfloor C_{mix} * \left(Q_p + Q_{gw}\right)\right\rfloor - \left(C_{gw} * Q_{gw}\right)}{Q_p}$$

$$C_p = \frac{[10 \text{ mg/L} * (158.6 \text{ ac-ft/EP} + 360 \text{ ac-ft/EP})] - (3.0 \text{ mg/L} * 360 \text{ ac-ft/EP})}{158.6 \text{ ac-ft/yr}}$$

C_p = 25.9 mg/L

Given the assumptions above, the percolate could have a value of less than 25.9 mg/L and theoretically not cause exceedance of the ground water standard of 10 mg/L.

7.7.5.2.3 Depth to Water/Travel Time

As discussed in Section 7.1, the estimated travel time of percolate to ground water and other critical factors should be evaluated to help determine whether vadose zone or ground water monitoring would be more practical and appropriate.

Differences in the thickness and composition of the vadose zone affects travel times and for certain constituents the attenuation of constituents percolating through this zone. For example, fractured basalt, if few or thin interbeds are present, provides rapid travel times and negligible treatment. In this case ground water monitoring may still be warranted, even in areas where the vadose zone thickness is substantial.

There are several computer models which may be utilized to characterize unsaturated flow. A simple method of estimating travel time through the vadose zone employs the unit gradient *Lumped Time of Travel Model* (c.f. Guymon, G.L., 1994 pp 103-104). In this model the system is: 1) assumed to be at steady-state with a uniform moisture content, 2) the vadose zone is unlayered, with uniform hydraulic characteristics, and 3) the hydraulic gradient is equal to unity. Under these conditions the hydraulic conductivity is equal to the net percolation rate (Guymon, 1994). The pore velocity (V) can then be estimated with:

$$V = P_o / \theta$$

Equation 7-8. Calculation of pore velocity (V).

Where:

P_o = net percolation rate (amount of water per unit time; typically expressed in terms such as feet/yr). This variable represents the net amount of water that may be expected to move below the crop root zone. (An example of how P_o may be calculated is found in Guymon, G.L. [1994] pp 81-83.)

θ = soil moisture content (volume of water/total soil volume) and is expressed in dimensionless terms as a decimal fraction. θ may be obtained indirectly from tensiometer data, given a soil-specific relationship between θ and soil tension (soil water characteristic curve), from gravimetric analysis of soil cores taken below the root zone soon after an irrigation event, or may be estimated from the use of unsaturated flow computer models. Also, θ may be estimated by use of Gardener's equations (Gardner 1958) (Eq. Equation 7-9 and Equation7-10) if ψ >= -1 atm of pressure head in the vadose zone. If the latter condition does not hold, other methods should be used (c.f. Guymon 1994 p. 70 ff.)

Guymon also references W.R. Gardner's equations in this model. Using these equations to estimate θ, one must first obtain an estimate of ψ, the pressure head in the vadose zone by using:

$$K(\Psi) = \frac{K_s}{A_k |\Psi|^{\beta} + 1}$$

Equation 7-9. Gardner equation for unsaturated hydraulic conductivity K(ψ).

Where:

K_s = the saturated hydraulic conductivity; and A_k and β, best fit parameters; are found in Guymon, (1994) p. 70, and are reproduced in Table 7-22.

K(ψ), the hydraulic conductivity at a given pressure head is taken to be equal to P_o.

Equation 7-9 is rearranged to solve for ψ.

$$|\Psi| = e^{\{\ln[(K_s - Po)/AkPo]/\beta\}}$$

Equation7-10. Solving Equation 9 for soil pressure head (Ψ).

Table 7-22. Approximate Gardner's Parameters for Calculating Unsaturated Hydraulic Conductivity

Soil Texture	K_s (cm· h^{-1})	A_k (ψ in cm of water)	β
Sand (dirty)	3.75	$0.132 \cdot 10^{-2}$	2.576
Sandy Loam	1.17	$0.127 \cdot 10^{-4}$	3.731
Silt Loam	0.30	$0.132 \cdot 10^{-4}$	3.135

From Gardner 1958.

Solving for ψ, this value is substituted into Equation 7-11 to obtain θ.

$$\theta = \frac{\theta_s}{A_w |\Psi|^{\alpha} + 1}$$

Equation 7-11. Gardner equation for calculating soil moisture content (θ).

Where:

θ_s = soil porosity expressed as a decimal. A_w and α, best fit parameters, are found in Guymon (1994) p. 51, and are reproduced in Tabe 7-24.

Table 7-23. Gardner Parameters for Soils

Soil Texture	Θ_s	A_w	α
Sand	0.36	0.0787	0.614
Sandy Loam	0.42	0.0149	0.743
Loam	0.50	0.0121	0.720
Silty Loam	0.46	0.0024	1.079
Clay Loam	0.39	0.0420	0.418
Silty Clay Loam	0.43	0.0128	0.488
Clay	0.44	0.0002	1.007

[a]Values are approximate and are primarily for ranges of pressure head between zero and -1 atm. Pore-water pressure units are in cm of water.
From Gardner 1958

Travel time (T) is then estimated by:

$$T = \frac{X}{V}$$

Equation7-12. Calculation of travel time (T).

Where:

X = thickness of the vadose zone (units of length).

V = pore velocity as defined previously

For example, if a rapid infiltration basin receives 85 inches of wastewater during a year's time and 80 inches is lost to deep drainage then:

$$P_o = K(\psi) = 80 \text{ inches/yr, or } 2.32 \text{ E-2 cm/hr}$$

If the vadose zone is composed of uniform sandy materials, we utilize Equation 7-10. Obtaining A_k = 0.132 E-2, β = 2.576, and K_s = 3.75 from Table A-10 (Guymon, 1994 p. 70), we solve for ψ:

$$|\Psi| = e^{\{\ln[(3.75 - 2.32 \cdot 10^{-2})/0.132 \cdot 10^{-2} * 2.32 \cdot 10^{-2}]/2.576\}} = 94.2 \text{ cm}$$

Next we utilize Equation 7-11, substituting ψ obtained from Equation A-10, obtaining θ_s = 0.36, A_w = 0.0787 and α = 0.614 from Guymon (1994) p. 51. This expression is then solved for θ:

$$\theta = \frac{0.36}{0.0787 \cdot 94.2^{0.614} + 1} = 0.16$$

Substituting P_o = 80 in/yr and θ = 0.16 into Equation 7-8, we obtain the pore velocity under steady-state conditions:

$$V = 80/0.16 = 500 \text{ in/yr or } 42 \text{ ft/yr}$$

If the vadose zone thickness were 50 feet then, using Equation 7-12, the travel time to ground water would be:

$$T = \frac{50}{42} = 1.2 \text{ yr}$$

7.7.6 Soil Monitoring Supplemental Information

7.7.6.1 Soil Sampling Form

Soil Sample Information Sheet

The original will not be returned to you. Keep yellow copy; send original to:
ISU Soil Testing Laboratory, G501 Agronomy, Ames, Iowa 50011.

Date____________________

Submitter ____

Address ____
Street or Rural Route

____
City State Zip Code

Phone ____

Lab Space—Do Not Use

payment code ______________ x ____________

$ ________________ adj ____________

CC ______________ #C ____________

Number of extra copies of report (limit 3) ___________ *(All copies of report will be sent to submitter.)*

Client name ________________________________ **Farm is in** ________________________ **County.**

Note: Recommendations are computer generated. Please use numbers in the boxes below.

				Must be filled in		Crop information (use crop codes listed below)		
Lab no. Do not use	Sample no.	Soil type*	No. of acres	Tillage depth† (inches)	✓ If irr.	Crop to be fertilized	Yield goal bu. or T/A	Test series requested (use test series codes below)

* Use soil map units (smu) from Soil Survey Maps
† If using reduced till or no-till, estimate depth of lime incorporation.

Crop codes (use one code per sample)

1. Corn or sorghum grain
2. Irrigated corn grain
3. Corn or sorghum silage
4. Corn-soybean sequence (2-year recommendation—give yield goal for both crops)
5. Sunflowers
6. Wheat
7. Oats: no forage seeding
8. Oats + forage seeding
9. Alfalfa topdress
10. Bluegrass
11. Tall grass: pasture
12. Tall grass: hay + pasture
13. Legume and grass pasture
14. Sorghum-sudan pasture
15. Soybeans

Test series codes (use one code per sample)	Cost/sample
1. Regular series (pH, lime, P, K)	$ 7.00
2. Regular series + O.M.	$10.00
3. Regular + Zinc	$11.00
4. Regular series + O.M. + Zinc	$14.00
5. pH and lime only	$ 4.00
6. Organic Matter only	$ 5.00
7. Zinc only	$ 5.50

For established charge accounts only:

________charge ________________County Extension
________charge ________________County ASC Office
________charge ________________________
Company name

. . . and justice for all
The Iowa Cooperative Extension Service's programs and policies are consistent with pertinent federal and state laws and regulations on nondiscrimination. Many materials can be made available in alternative formats for ADA clients.

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Note: Please provide as much information as possible. Fertilizer recommendations are modified based on soil type. If soil type is not supplied, we will assume that subsoil P and K are very low.

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7.7.6.2 Soil Analytical Methods

Table 7-24. Common Soil Analytes and Methods.

Parameter	Abbreviations	Units	Standard Methods(1)	Comments
pH	--	S.U.	12-2.6; 12-2.7 pp 206-9	pH of saturated paste or 1:1 dilution or WSP6 S-2.10
% Organic Matter	%OM	% of oven dried soil(2)	29-4 pp. 574-7	or WSP S-9.10, S-9.20
Electrical Conductivity	EC	mmhos/cm	10-1; 10-2 (esp. 10-2.3.1); 10-3 (esp. 10-3.3)	E.C. of saturated paste extract Ag handbook 60, p. 8); or WSP S-1.20
% moisture	--	% of oven dried soil(2)	7-2.2 pp. 92-96 gravimetric w/oven drying(2)	
Texture	--	--	USDA 1975(3)	percent sand, silt & clay by hydrometer method[2] or pipette method[2] compared to textural triangle to determine textural classification
Sodium Absorption Ratio	SAR	--	calculation (see USDA Agricultural Handbook 60)	soluble conc. of Na, Ca, & Mg from saturated paste; WSP S-1.60
Total Kjeldahl Nitrogen	TKN-N	mg/kg	31-1 through 31-4 pp. 595-618	also used is Total N by combustion (AOAC 955.04 1990 edition) or WSP S-8.10
Ammonium Nitrogen	NH4-N	mg/kg	33-1 through 33-7 pp. 643-676	plant available including soluble & exchangeable (See also AOAC 920.03 1990 edition)
Nitrate Nitrogen	NO3-N	mg/kg	33-1 through 33-6 pp. 643-671; 33-8, pp. 363-682	plant available; WSP S-3.10
Sodium	Na	Meq/100 g	9-1 through 9-3 pp. 159-161; 13-4 pp. 238-241	Exchangeable; WSP S-1.60
Potassium	K	Meq/100 g	9-1 through 9-3 pp. 159-161; 13-3 pp. 228-238	Exchangeable; WSP S-5.10
Calcium	Ca	Meq/100 g	9-1 through 9-3 pp. 159-161; 14 pp. 247-262	Exchangeable; WSP S-5.10
Magnesium	Mg	Meq/100 g	9-1 through 9-3 pp. 159-161; 14 pp. 247-262	Exchangeable; WSP S-5.10
Manganese	Mn	mg/kg	18 (esp. 18-3.4) pp. 313-322	DTPA extractable; WSP S-6.10
Iron	Fe	mg/kg	17-4 pp. 308-311	DTPA extractable; WSP S-6.10
Chloride	Cl	meq/100g	26-3 pp. 455-462	water soluble; WSP S-1.40
Sulfate	SO4	mg/kg	28-3 pp. 518-522	water soluble
Cation Exchange Capacity	CEC	meq/100g	8 pp. 149-157	Do not use sum of bases method for CEC with extractable analyses for Ca, Mg, K, and Na.
Phosphorus	P	mg/kg	24-5.1 through 24.5.5 pp. 416-423	Plant Available bicarbonate extraction (Olson) common for neutral to alkaline soils (WSP S-4.10); Use Bray method for acidic soils (S-4.20; Bray P-1).

Notes:

1. Methods of Soil Analysis, Part 2, Chemical and Microbial Properties, 2nd Edition. Edited by A.L. Page, R.H. Miller and D.R. Kenney. ASA SSSA Publication, Madison WI 1982. #9 in monograph Series.
2. Methods of Soil Analysis, Part 1, Physical and Mineralogical Properties, including Statistics of Measurement and Sampling. Edited by C.A. Black et. al. ASA SSSA Publication, Madison WI 1965. #9 in monograph Series.
3. Soil Survey Staff, Soil Taxonomy: A Basic system of Soil Classification for Making and Interpreting Soil Surveys, Soil Conservation Service, USDA, Washington, D.C., Agriculture Handbook 436 (December 1975).
4. Method of analysis should be reported when submitting data to DEQ.
5. Association of Official Analytical Chemists, Official Methods of Analysis (AOAC). 1990 15th edition. All methods cited in this appendix are recommended methods. Other comparable methods yielding the same interpretive results are acceptable unless otherwise stated in the Land Application of Wastewater Permit.
6. Western States Agricultural Laboratory Exchange Program: Suggested Soil and Plant Analytical Methods. Miller, R. O. and Amacher, J. 1994 version 1.00.
7. Methods of Soil Analysis Used in the Soil Testing Laboratory at Oregon State University. Horneck, D. A., Hart, J. M., Topper, K., and Koespell, B., September 1989. Agricultural Experimental Station, Oregon State University, SM 89:4.

7.7.7 Soil Monitoring for Grazing Management

Grazing animals have the potential to adversely impact soil quality by compacting the soil and decreasing infiltration capacity. Decreasing the soils' infiltration capacity decreases the soils' ability to transport water, nutrients, oxygen and carbon dioxide – all essential processes for crop growth. For most soils, soil moisture status is a critical parameter to consider when assessing the potential of soil quality impacts. Generally, the higher the soil moisture content, the greater the potential for the soil to compress under pressure and decrease the soils infiltration capacity. Irrigation as well as precipitation events can change the soil water status. Soils should be monitored, especially after such events, to see whether they are too moist to bear the traffic of grazing animals. Soils can be sampled and evaluated for soil moisture according to the 'feel method' described in Table 7-25 (from Ashley et al. 1997).

"The feel method involves collecting soil samples in the root zone with a soil probe or spade. Then, the water deficit for each sample is estimated by feeling the soil and judging the soil moisture as outlined in" the table below. "Soil samples should be taken at several depths in the root zone at several places in the field." (Wright and Bergsrud, 1991). Grazing should not be conducted during soil conditions represented by shaded cells in the table.

Table 7-26 shows generalized drainage times for common soil textural classes. Times reflect drainage to field capacity. Unfortunately, field capacity is probably close to optimum moisture for compaction. Soils should be allowed to drain and dry beyond field capacity in the surface to be suitable for grazing After irrigating, soils should be allowed to drain at least as long as these drainage times. After this, soils should be evaluated by the 'feel method' to determine when grazing would be appropriate. Note that intensive, rotational grazing provides for short intense grazing on small paddocks and minimizes compaction from animals because they are on any one part of the field shorter than extended grazing.

Table 7-25. Feel method chart for estimating soil moisture

(Number indicates inches of water deficit per one foot of soil.)
Shaded cells indicate soil conditions which may be too wet for grazing.

Soil-Moisture Deficiency	Coarse Texture (sand, loamy sand)	Moderately Coarse Texture (sandy loam)	Medium Texture (silt loam, loam)	Fine and Very Fine Texture (clay loam, clay)
0% (Field capacity)	Upon squeezing, no free water appears on soil but wet outline of ball is left on hand. (0.0)	Upon squeezing, no free water appears on soil but wet outline of ball is left on hand. (0.0)	Upon squeezing, no free water appears on soil but wet outline of ball is left on hand. (0.0)	Upon squeezing, no free water appears on soil but wet outline of ball is left on hand. (0.0)
0 – 25%	Tends to stick together slightly, sometimes forms a very weak ball under pressure. (0.0 to 0.2)	Forms weak ball, breaks easily will not slick. (0.0 to 0.4)	Forms a ball, is very pliable, slicks readily if relatively high in clay. (0.0 to 0.5)	Easily ribbons out between fingers, has slick feeling. (0.0 to 0.6)
25 – 50%	Appears to be dry, will not form a ball with pressure. (0.2 to 0.5)	Tends to ball under pressure, but seldom holds together. (0.4 to 0.8)	Forms a ball somewhat plastic, will sometimes slick slightly with pressure. (0.5 to 1.0)	Forms a ball, ribbons out between thumb and forefinger. (0.6 to 1.2)
50 – 75%	Appears to be dry, will not form a ball with pressure. (0.5 to 0.8)	Appears to be dry, will not form a ball. (0.8 to 1.2)	Somewhat crumbly but holds together from pressure. (1.0 to 1.5)	Somewhat pliable, will ball under pressure. (1.2 to 1.9)
75 – 100% **(100% is permanent wilt point)**	Dry, loose, single-grained, flows through fingers. (0.8 to 1.0)	Dry, loose, flows through fingers. (1.2 to 1.5)	Powdery, dry, sometimes slightly crusted but easily broken down into powdery condition. (1.5 to 2.0)	Hard, baked, cracked, sometimes has loose crumbs on surface. (1.9 to 2.5)

Note: A ball is formed by squeezing a handful of soil very firmly.
Source: Israelsen and Hansen. *1962. Irrigation Principals and Practices.* Third Edition. New York: John Wiley and Sons, Inc.

Table 7-26. Generalized Drainage Times for Uniform Soil Profiles of Varying Textures

Texture	**Drainage Time (Range in days)**
Loamy Sand	0.5 - 2
Sandy Loam	3 - 4
Silt Loam	4 - 6
Clay Loam	5 - 7

Carlisle and Phillips, 1976 and Donahue et al., 1977

7.7.8 Wastewater Monitoring Supplemental Information

7.7.8.1 NPDES Compliance Inspection Manual, Chapter 6

Source:
http://www.epa.gov/compliance/resources/publications/monitoring/cwa/inspections/npdesinspect/npdesmanual.html

6. FLOW MEASUREMENT

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6-i

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6. A. Evaluation of Permittee's Flow Measurement

Objectives and Requirements

To comply with the permit requirements established under the National Pollutant Discharge Elimination System (NPDES), the permittee must accurately determine the quantity of wastewater being discharged. Discharge flow an measurement is an integral part of the NPDES program, it is important that the inspector evaluate the accuracy of the measurement.

In addition to providing usable information for enforcement purposes, flow measurement serves to:

- Provide data for pollutant mass loading calculations
- Provide operating and performance data on the wastewater treatment plant
- Compute treatment costs, based on wastewater volume
- Obtain data for long-term planning of plant capacity, versus capacity used
- Provide information on Infiltration and Inflow (I/I) conditions, and the need for cost-effective I/I correction

A Flow Measurement Inspection Checklist for the inspector's use appears at the end of this chapter.

Evaluation of Facility-Installed Flow Devices and Data

There are two types of wastewater flow: closed channel flow and open channel flow. Closed channel flow occurs under pressure in a liquid-full conduit (usually a pipe). The facility will usually have a metering device inserted into the conduit which measure flow. Examples of closed channel flow measuring devices are the Venturi meter, the Pitot tube, the paddle wheel, the electromagnetic flowmeter, Doppler, and the transit-time flowmeter. In practice, closed channel flow is normally encountered between treatment units in a wastewater treatment plant, where liquids and/or sludges are pumped under pressure.

Open channel flow occurs in conduits that are not liquid-full. Open channel flow are partially full pipes not under pressure. Open channel flow is the most prevalent type of flow at NPDES-regulated discharge points.

Measure open channel flow using primary and secondary devices. Primary devices are standard hydraulic structures, such as flumes and weirs, that are inserted in the open channel. Inspectors can obtain accurate flow measurements merely by measuring the depth of liquid (head) at the specific point in the primary device. In a weir application, for example, the flow rate is a function of the head of liquid above the weir crest.

Facilities use secondary devices in conjunction with primary devices to automate the flow measuring process. Typically, secondary devices measure the liquid depth in the primary device and convert the depth measurement to a corresponding flow, using established mathematical relationships. Examples of secondary devices are floats, ultrasonic transducers, bubblers, and transit-time flowmeters. A recorder generally measures the output of the secondary device transmitted to a recorder and/or totalizer to provide instantaneous and historical flow data to the operator. Outputs may also be transmitted to sampling systems to facilitate flow proportioning. Appendix O contains further information on flow measurement devices.

The inspector must assure the permittee obtains accurate wastewater flow data to calculate mass loading (quantity) from measured concentrations of pollutants discharged as required by many NPDES permits. The permittee must produce data that meet requirements in terms of precision and accuracy. Precision refers to data reproducibility or the ability to obtain consistent data from repeated measurements of the same quantity. Accuracy refers to the agreement between the amount of a component measured by the test and the amount actually present.

The accuracy of flow measurement (including both primary and secondary devices) varies widely with the device, its location, environmental conditions, and other factors such as maintenance and calibration. Faulty fabrication, construction, and installation of primary devices are common sources of errors. Improper calibration, misreading, and variation in the speed of totalizer drive motors are major errors related to secondary devices. See Appendix O - "Supplement Flow Measurement Information." When evaluating facility installed devices, the inspector should do the following:

- Verify that the facility has installed primary and secondary devices according to manufacturer's manual instructions.
- Inspect the primary device for evidence of corrosion, scale formation, or solids accumulation that may bias the flow measurement.
- Verify that weirs are level, plumb, and perpendicular to the flow direction.
- Verify that flumes are level, the throat walls (narrowed section of flume) are plumb, and the throat width is the standard size intended.
- Inspect historical records (i.e., strip charts and logs) for evidence of continuous flow measurements. Compare periods of missing data with maintenance logs for explanations of measuring system problems.
- Observe the flow patterns near the primary device for excessive turbulence or velocity. The flow lines should be straight.
- Ensure that the flow measurement system or technique being used measures the entire wastewater discharge as required by the NPDES permit. Inspect carefully the piping to determine whether there are any wastewater diversions, return lines, or bypasses around the system. Make sure the system meets the permit requirement, such as instantaneous or continuous, daily, or other time interval measures. Noted anomalies in the inspection report.
- Verify that the site chosen for flow measurement by the facility is appropriate and is in

accordance with permit requirements.

- Verify that the site chosen by the facility for flow measurement is suitable for type of discharge, flow range, suspended solids concentration, and other relevant factors.

- Verify that the facility has closed channel flow measuring devices where the pipe is always full. If these devices are used, then there must be also a means for the permittee and regulatory agencies/inspector to verify the accuracy of these meters. Primary flow measuring devices such as weirs and flumes are ideal for this purpose.

- Verify that the facility uses appropriate tables, curves, and formulas to calculate flow rates.

- Review and evaluate calibration and maintenance programs for the discharger's flow measurement system. The permit normally requires the facility to check the calibration regularly by the permittee. The facility must ensure that their flow measurement systems are calibrated by a qualified source at least once a year to ensure their accuracy. Lack of such a program is considered unacceptable for NPDES compliance purposes.

- Verify that the facility calibrates flowmeters across the full range of expected flow.

- Verify that primary and secondary devices are adequate for normal flow as well as maximum expected flow. Note whether the flow measurement system can measure the expected range of flow.

- Collect accurate flow data during inspection to validate self monitoring data collected by the permittee.

- The facility must install a flow measuring system that has the capability of routine flow verification by the permittee or appropriate regulatory personnel.

Evaluation of Permittee Data Handling and Reporting

The permittee or facility must keep flow measurement records for a minimum period of three years as the permit requires. Many flow measuring devices produce a continuous flowchart for plant records. Flow records should contain date, flow, time of reading, and operator's name, if applicable the facility must also record. The facility should record maintenance, inspection dates, and calibration data.

The inspector should review the permittee's records and note the presence or absence of data such as:

- Frequency of routine operational inspections

- Frequency of maintenance inspections

- Frequency of flowmeter calibration (should be as specified in permit, generally at least once per year)

- Irregularity or uniformity of flow.

Evaluation of Permittee Quality Control

The inspection should evaluate following quality control issues during a compliance inspection to ensure:

- Proper operation and maintenance of equipment
- Accurate records
- Sufficient inventory of spare parts
- Valid flow measurement techniques
- Precise flow data
- Adequate frequency of calibration checks.

Evaluate precision of float driven flow meters when flows are stable. Push the float gently downward, hold for 30 seconds, then allowed to return normally. The recorded flow rate should be the same before and after the float was moved. Evaluate accuracy by measuring the instantaneous flow rate at the primary device used at the facility and comparing the value against the value on the meter, graph, integrator, or company record. The difference between two stable totalizer readings (flow is steady for 10 minutes or more) should not exceed ±10 percent of the instantaneous flow measured at the primary device. Note that most flow measurement systems have both an instantaneous meter readout as well as a totalizer. Both of these devices should be in agreement but that is not always the case due to electrical and other various malfunctions in the flow measuring system. In most cases, the totalizer reading will be what is reported by the permittee. If this is the case, then that device should be checked for accuracy and the permittee's flow measuring system rated accordingly.

In addition, the inspector can evaluate accuracy by installing a second flow measurement system, sometimes referred to as a reference system. Agreement in measured flow rates between the two systems should be within ±10 percent of the reference rate if all conditions are as recommended for the systems.

6. B. Flow Measurement Compliance

Objectives

The current NPDES program depends heavily on the permittee's submittal of self-monitoring data. The flow discharge measured during the NPDES compliance inspection should verify the flow measurement data collected by the permittee, support any enforcement action that may be necessary, and provide a basis for reissuing or revising the NPDES permit.

Flow Measurement System Evaluation

The responsibility of the inspector includes collecting accurate flow data during the inspection and validating data collected during the permittee's self-monitoring.

The NPDES inspector must check both the permittee's flow data and the flow measurement system to verify the permittee's compliance with NPDES permit requirements. When evaluating a flow measurement system, the inspector should consider and record findings on the following:

- Whether the system measures the entire discharge flow.
- The system's accuracy and good working order. This wil include a thorough physical inspection of the system and comparison of system readings to actual flow or those obtained with calibrated portable instruments.
- The need for new system equipment.
- The existence or absence of a routine calibration and maintenance program for flow measurement equipment.

If the permittee's flow measurement system is accurate within ±10 percent, the inspector should use the installed system. If the flow sensor or recorder is found to be inaccurate, the inspector should determine whether the equipment can be corrected in time for use during the inspection. If the equipment cannot be repaired in a timely manner, use the portable flow sensor and recorder used to assess the accuracy of the permittee's system for the duration of the inspection. If nonstandard primary flow devices are being used, request the permittee to supply data on the accuracy and precision of the method being employed.

For flow measurement in pipelines, the inspector may use a portable flowmeter. The inspector should select a flowmeter with an operating range wide enough to cover the anticipated flow to be measured. The inspector should test and calibrate the selected flowmeter before use. The inspector should select the site for flow measurement according to permit requirements and install the selected flowmeter according to the manufacturer's specifications. The inspector should use the proper tables, charts, and formulas as specified by the manufacturer to calculate flow rates.

Four basic steps are involved in evaluating the permittee's flow measurement system:

- Physical inspection of the primary device
- Physical inspection of the secondary device and ancillary equipment
- Flow measurement using the primary/secondary device combination of the permittee
- Certification of the system using a calibrated, portable instrument.

The following sections present, procedures for inspecting the more common types of primary and secondary devices, for measuring flow using common permanent and portable systems, and for evaluating flow data. Please note that the number of primary/secondary device permutations is limitless; therefore, it is not feasible to provide procedures for all systems. When encountering systems other than those discussed here the inspector should consult the manufacturers manual/personnel for advice before preparing a written inspection procedure.

Primary Device Inspection Procedures

The two most common open channel primary devices are sharp-crested weirs and Parshall flumes. Common sources of error when using them include the following:

- Faulty fabrication—weirs may be too narrow or not "sharp" enough. Flume surfaces may be rough, critical dimensions may exceed tolerances, or throat walls may not be vertical.

- Improper installation—the facility may install weirs and flumes too near pipe elbows, valves, or other sources of turbulence. The devices may be out of level or plumb.

- Sizing errors—the primary device's recommended applications may not include the actual flow range.

- Poor maintenance—primary devices corrode and deteriorate. Debris and solids may accumulate in them.

Specific inspection procedures for the sharp-crested weir, the Parshall flume, and the Palmer-Bowlus flume devices follow.

Sharp-Crested Weir Inspection Procedures

- Inspect the upstream approach to the weir.

  - Verify that the weir is perpendicular to the flow direction.

  - Verify that the approach is a straight section of conduit with a length at least 20 times the maximum expected head of liquid above the weir crest.

  - Observe the flow pattern in the approach channel. The flow should occur in smooth stream lines without velocity gradients and turbulence.

  - Check the approach, particularly in the vicinity of the weir, for accumulated solids, debris, or oil and grease. The approach must have no accumulated matter.

- Inspect the sharp-crested weir.
  - Verify that the crest of the weir is level across the entire conduit traverse.
  - Measure the width of the weir crest. The edge of the weir crest should be no more than 1/8-inch thick.
  - Make certain the weir crest corresponds to zero gauge elevation (zero output on the secondary device).
  - Measure the angle formed by the top of the crest and the upstream face of the weir. This angle must be 90 degrees.
  - Measure the chamfer (beveled edge) on the downstream side of the crest. The chamfer should be approximately 45 degrees.
  - Visually survey the weir-bulkhead connection for evidence of leaks or cracks which permit bypass.
  - Measure the height of the weir crests above the channel floor. The height should be at least twice the maximum expected head (2H) of liquid above the crest.
  - Measure the width of the end contraction. The width should be at least twice the maximum expected head (2H) of the liquid above the crest.
  - Inspect the weir for evidence of corrosion, scale formation, or clinging matter. The weir must be clean and smooth.
  - Observe flow patterns on the downstream side of the weir. Check for the existence of an air gap (ventilation) immediately adjacent to the downstream face of the weir. Ventilation is necessary to prevent a vacuum that can induce errors in head measurements. Also ensure that the crest is higher than the maximum downstream level of water in the conduit.
  - Verify that the nappe is not submerged and that it springs free of the weir plate.
  - If the weir contains a V-notch, measure the apex angle. The apex should range from 22.5 degrees to 90 degrees. Verify that the head is between 0.2 and 2.0 feet. The weir should not be operated with a head of less than 0.2 feet since the nappe may not spring clear of the crest.

King's *Handbook of Hydraulics*, 1963, frequently referenced throughout this chapter, provides a detailed discussion on weirs.

Parshall Flume Inspection Procedures

- Inspect the flume approach.
  - The flow pattern should be smooth with straight stream lines, be free of turbulence, and have a uniform velocity across the channel.
  - The upstream channel should be free of accumulated matter.
- Inspect the flume.
  - The flume should be located in a straight section of the conduit.
  - Flow at the entrance should be free of "white" water.
  - The flume should be level in the transverse and translational directions.
  - Measure the dimensions of the flume. Dimensions are strictly prescribed as a function of throat width (see Figure I-5 in Appendix O for critical dimensions).
  - Measure the head of liquid in the flume and compare with the acceptable ranges in Table I-4 in Appendix O.
- Inspect the flume discharge.
  - Verify that the head of water in the discharge is not restricting flow through the flume. The existence of a "standard wave" is good evidence of free flow and verifies that there is no submergence present.
  - Verify whether submergence occurs at near maximum flow (e.g., look for water marks on the wall).

Palmer-Bowlus Flume Inspection Procedures

- Inspect the flume approach as outlined above (these flumes are seldom used for effluent flow measurement).
- Inspect the flume.
  - The flume should be located in a straight section of the conduit.
  - Flow at the entrance should be free of "white" water.
  - Observe the flow in the flume. The profile should approximate that depicted in Figure I-8 in Appendix O.
  - The flume should be level in the transverse direction and should not exceed the translational slope in Table I-6 in Appendix O.

- Measure the head of water in the flume. Head should be within the ranges specified in Table I-6 in Appendix O.

- Inspect the flume discharge.

  - Verify that free flow exists. Look for the characteristic "standing wave" in the divergent section of the flume.

Venturi Meter Inspection Procedures

- Verify that the facility installed the Venturi meter according to manufacturer's instructions.

- Verify that the facility installed the Venturi meter downstream from a straight and uniform section of pipe, at least 5 to 20 diameters, depending on the ratio of pipe to throat diameter and whether straightening vanes are installed upstream. (Installation of straightening vanes upstream will reduce the upstream piping requirements.)

- Verify that the pressure measuring taps are free of debris and are not plugged.

- Calibrate the Venturi meter in place by either the volumetric method or the comparative dye dilution method to check the manufacturer's calibration curve or to develop a new calibration curve.

Secondary Device Inspection Procedures

The following are common sources of error in the use of secondary devices:

- Improper location—gauge is located in the wrong position relative to the primary device.
- Inadequate maintenance—gauge is not serviced regularly.
- Incorrect zero setting—zero setting of gauge is not the zero point of the primary device.
- Operator error—human error exists in the reading.

Specific inspection procedures follow.

Flow Measurement in Weir Applications

- Determine that the head measurement device is positioned 3 to 4 head lengths upstream of a weir.

- Verify that the zero or other point of the gauge is equal to that of the primary device.

The inspector should use an independent method of measuring head, such as with a yardstick or carpenter's rule (be sure to take your measurement at least four times the maximum head upstream and from the weir and convert to nearest hundredth of a foot). To determine flow rate, use the appropriate head discharge relationship formula (see Table I-1 in Appendix O).

Flow Measurement in Parshall Flume Applications

Flow Measurement—Free-Flow Conditions.

- Determine upstream head (H_a) using staff gauge.
  - Verify that staff gauge is set to zero head. Use either a yardstick or carpenter's rule.
  - Verify that staff gauge is at proper location (two-thirds the length of the converging section back from the beginning of the throat).
  - Read to nearest division the gauge division at which liquid surface intersects gauge.
  - Read H_a in feet from staff gauge.
- To determine flow rate, use Figure I-6 in Appendix O in the unit desired, use tables published in flow measurement standard references, or calculate using the coefficients in Table I-5 in Appendix O.

Flow Measurement—Submerged-Flow Condition.

Generally it is difficult to make field measurements with submerged-flow conditions. In cases when measurements can be obtained (using a staff or float gauge), the procedures listed below should be followed:

- Determine upstream head using staff or float gauge.
  - Read to nearest division and, at the same time as for H_b, the gauge division at which liquid surface intersects gauge.
  - Calculate H_a from gauge reading.
- Determine downstream head (H_b) using staff or float gauge.
  - H_b refers to a measurement at the crest.
  - Read to nearest division, and at the same time as for H_a, the gauge division at which liquid surface intersects gauge.
  - Calculate H_b from staff reading.

- Determine flow rate.
  - Calculate percent submergence:

    $$\left[\frac{H_b}{H_a}\right] \times 100.$$

  - Consult Table I-6 in Appendix O.
  - When a correction factor is obtained, use H_a and find free-flow from Figure I-6.
  - Multiply this free-flow value by the correction factor to obtain the submerged flow.

The inspector may use an independent method of measuring head, such as a yardstick or carpenter's rule at the proper head measurement point. Because of the sloping water surface in the converging section of a flume, it is essential that the proper head measurement point be used.

Flow Measurement in Palmer-Bowlus Flume Applications

- Obtain head measurements as in the Parshall Flume application, using the secondary device. The head is the height of water above the step. The total depth upstream of the step is not the head.
- Refer to manufacturer-supplied discharge tables to convert head measurements to flow data. Palmer-Bowlus flumes, unlike Parshall flumes, are not constructed to standard dimensional standards. The inspector must not use discharge tables supplied by other manufacturers.

Verification

Most flow measurement errors result from inadequate calibration of the flow totalizer, and recorder. If the inspector has determined that the primary device has been installed properly, verification of the permittee's system is relatively simple. Compare the flow determined from the inspector's independent measurement to the flow of the permittee's totalizer or recorder. The inspector's flow measurements should be within 10 percent of the permittee's measurements to certify accurate flow measurement. Optimally, flow comparisons should be made at various flow rates to check system accuracy.

When the permit requires that the daily average flow be measured by a totalizing meter, the inspector should verify that the totalizer is accurate, i.e., properly calibrated. This can be done during a period of steady flow by reading the totalizer and at the same time starting a stopwatch. Start the stopwatch just as a new digit starts to appear on the totalizer. After 10 to 30 minutes, the totalizer should be read again; just as a new digit begins to appear, the stop watch is read. Subtract the two totalizer readings to determine, the total flow over the measured time period. Calculate the flow rate in gallons per minute by using the time from the stop watch. Compare this flow rate to the flow determined by actual measurement of the head made at the primary device at the time interval. Consider the calibration of the totalizer satisfactory if the two flows are within 10 percent of each other, when the actual measured flow is used as the known value, or divisor, in the percent calculation.

6. C. References and Flow Measurement Inspection Checklist

References

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Thorsen, T., and R. Oden. 1975. "How to Measure Industrial Wastewater Flow," *Chemical Engineering*, 82(4): 95-100.

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U.S. Department of the Interior (USDI), Bureau of Reclamation. 1967. *Water Measurement Manual*, 2nd Ed. (Contains tables of various flow measurement devices.)

U.S. Environmental Protection Agency, Office of Water Enforcement and Permits Enforcement Division. September 1981. *NPDES Compliance Flow Measurement Manual.*

FLOW MEASUREMENT INSPECTION CHECKLIST

A. GENERAL

Yes No N/A	1. a.	Primary flow measuring device properly installed and maintained.
Yes No N/A	b.	Flow measured at each outfall? __________ Number of outfalls? __________
Yes No N/A	c.	Is there a straight length of pipe or channel before and after the flowmeter of at least 5 to 20 diameters?
Yes No N/A	d.	If a magnetic flowmeter is used, are there sources of electric noise in the near vicinity?
Yes No N/A	e.	Is the magnetic flowmeter properly grounded?
Yes No N/A	f.	Is the full pipe requirement met?
Yes No N/A	2. a.	Flow records properly kept.
Yes No N/A	b.	All charts maintained in a file.
Yes No N/A	c.	All calibration data entered into a log book.
Yes No N/A	3.	Actual discharged flow measured.
Yes No N/A	4.	Effluent flow measured after all return lines.
Yes No N/A	5.	Secondary instruments (totalizers, recorders, etc.) properly operated and maintained.
Yes No N/A	6.	Spare parts stocked.
Yes No N/A	7.	Effluent loadings calculated using effluent flow.

B. FLUMES

Yes No N/A	1.	Flow entering flume reasonably well-distributed across the channel and free of turbulence, boils, or other disturbances.
Yes No N/A	2.	Cross-sectional velocities at entrance relatively uniform.
Yes No N/A	3.	Flume clean and free of debris and deposits.
Yes No N/A	4.	All dimensions of flume accurate and level.
Yes No N/A	5.	Side walls of flume vertical and smooth.
Yes No N/A	6.	Sides of flume throat vertical and parallel.
Yes No N/A	7.	Flume head being measured at proper location.
Yes No N/A	8.	Measurement of flume head zeroed to flume crest.
Yes No N/A	9.	Flume properly sized to measure range of existing flow.
Yes No N/A	10.	Flume operating under free-flow conditions over existing range of flows.
Yes No N/A	11.	Flume submerged under certain flow conditions.
Yes No N/A	12.	Flume operation invariably free-flow.

FLOW MEASUREMENT INSPECTION CHECKLIST
(Continued)

C. WEIRS

Yes No N/A	1. What type of weir does the facility use?
Yes No N/A	2. Weir exactly level.
Yes No N/A	3. Weir plate plumb and its top and edges sharp and clean.
Yes No N/A	4. Downstream edge of weir is chamfered at 45°.
Yes No N/A	5. Free access for air below the nappe of the weir.
Yes No N/A	6. Upstream channel of weir straight for at least four times the depth of water level and free from disturbances.
Yes No N/A	7. Distance from sides of weir to side of channel at least 2H.
Yes No N/A	8. Area of approach channel at least (8 × nappe area) for upstream distance of 15H.
Yes No N/A	9. If not, is velocity of approach too high?
Yes No N/A	10. Head measurements properly made by facility personnel.
Yes No N/A	11. Leakage does not occur around weir.
Yes No N/A	12. Use of proper flow tables by facility personnel.

D. OTHER FLOW DEVICES

	1. Type of flowmeter used:
	2. What are the most common problems that the operator has had with the flowmeter?
	3. Measured wastewater flow: ________ mgd; Recorded flow: ________; Error ________%

E. CALIBRATION AND MAINTENANCE

Yes No N/A	1. Flow totalizer properly calibrated.
	2. Frequency of routine inspection by proper operator: ________/day.
	3. Frequency of maintenance inspections by plant personnel: ________/year.
Yes No N/A	4. Flowmeter calibration records kept. Frequency of flowmeter calibration: ________/month.
Yes No N/A	5. Flow measurement equipment adequate to handle expected ranges of flow rates.
Yes No N/A	6. Calibration frequency adequate.

Table 7-27. Wastewater Monitoring for Industrial Wastewater Land Application Facilities

Frequency	**Monitoring Point**	**Description/Type of Monitoring**	**Parameters**
Daily	Flow meter	Flow of wastewater into land application system	Volume (million gallons and acre-inches) to each hydraulic management unit, record monthly and annually
Annually	Each hydraulic management unit	Calculate non-growing season wastewater loading rate	Million gallons & Inches/ non-growing season
Annually	Each hydraulic management unit	Calculate growing season wastewater loading rate	Million gallons & Inches/ growing season
Annually	All flow measurement locations.	Flow measurement calibration of all flows to land application.	Document the flow measurement calibration of all flow meters and pumps used directly or indirectly measure all wastewater, tail water, flushing water, and supplemental irrigation water flows applied to each hydraulic management unit.
Annually	All supplemental irrigation pumps directly connected to the wastewater distribution system.	Backflow testing	Document the testing of all backflow prevention devices for all supplemental irrigation pumps directly connected to the wastewater distribution system(s). Report the testing date(s) and results of the test (pass or fail). If any test failed, report the date of repair or replacement of backflow prevention device, and if the repaired/replaced device is operating correctly.
Monthly	Effluent to land application	Wastewater quality into land application system – 24-hr. Composite	Chemical Oxygen Demand, Total Kjeldahl Nitrogen, Ammonia-Nitrogen, Nitrite + Nitrate-Nitrogen, Total Phosphorous, Chloride, Electrical Conductivity, Potassium, pH
Quarterly	Effluent to land application	Wastewater quality into land application system	Total Dissolved Inorganic Solids (TDIS) – See Table B-1. Submit analysis of individual ions in addition to TDIS.
Quarterly (for the first year only, 4 sample events)	Effluent to land application	Wastewater quality into land application system – 24-hr. composite.	Total Dissolved Solids (TDS), Volatile Dissolved Solids (VDS) for NVDS determination (i.e. NVDS = TDS – VDS)
Quarterly (for the first year only, 4 sample events)	Effluent to land application	Grab sample for bacteria	Colony numbers for Fecal Coliform, Total Coliform, Fecal Streptococcus and Pseudomonas, standard presence / absence test for Listeria (if present, determine specific type)
Daily	Flow meter or Calibrated Pump Rate	Supplemental Irrigation Water	Volume (million gallons and acre-inches) to each Hydraulic Management Unit , report monthly and annually.
Twice per year (May and Oct)	Nearest Surface Water – DEQ shall review and approve locations prior to initial sampling event.	Grab samples of surface water upstream and downstream from land application site.	Nitrate + Nitrite Nitrogen, Total Phosphorous, , Total Dissolved Solids, , Total Kjeldahl Nitrogen
Twice per year (May and Oct)	Supplemental Irrigation at diversions	Grab sample	Nitrate + Nitrite Nitrogen, Total Phosphorous, Total Dissolved Solids, , Chloride, Total Kjeldahl Nitrogen

Table 7-28. Wastewater Monitoring for Municipal Wastewater Land Application Facilities.

Frequency	Monitoring Point	Description and Type of Monitoring	Parameters
Daily (when land applying)	Discharge Point of Wastewater to Land Application (Flow Meter)	Volume of Wastewater land applied	Gallons/Month and acre-inches/month applied to each Hydraulic Management Unit
Annually	Each hydraulic management unit	Calculate non-growing season wastewater loading rate	Million gallons & Inches/ non-growing season
Annually	Each hydraulic management unit	Calculate growing season wastewater loading rate	Million gallons & Inches/ growing season
Annually	All flow measurement locations.	Flow measurement calibration of all flows to land application.	Document the flow measurement calibration of all flow meters and pumps used directly or indirectly measure all wastewater, tail water, flushing water, and supplemental irrigation water flows applied to each hydraulic management unit.
Annually	All supplemental irrigation pumps directly connected to the wastewater distribution system.	Backflow testing	Document the testing of all backflow prevention devices for all supplemental irrigation pumps directly connected to the wastewater distribution system(s). Report the testing date(s) and results of the test (pass or fail). If any test failed, report the date of repair or replacement of backflow prevention device, and if the repaired/replaced device is operating correctly.
Monthly (when land applying)1	Discharge Point of Wastewater to Land Application	grab sample	Total Kjeldahl nitrogen, nitrate+nitrite-nitrogen, TDS, pH, COD, total phosphorus
Daily (when land applying)	Flow Meter or Calibrated Pump Rate	Supplemental Irrigation Water	Gallons/Month and acre-inches/month applied to each Hydraulic Management Unit
Annually	Supplemental Irrigation Water at diversions	Grab Sample	Total Kjeldahl nitrogen, nitrate+nitrite-nitrogen, TDS, total phosphorus
During Application Season **For total coliform, monitoring frequency depends on level of treatment.** **1. 2.2 / 100 ml. - Twice Weekly** **2. 23 / 100 ml. - Weekly** **3. 230 / 100 ml. - Twice Monthly**	Discharge Point of Wastewater to Land Application	grab sample	Total Coliform
Twice per year (May and Oct)	Nearest Surface Water – DEQ shall review and approve locations prior to initial sampling event.	Grab samples of surface water upstream and downstream from land application site.	Nitrate + Nitrite Nitrogen, Total Phosphorous, , Total Dissolved Solids, Total Kjeldahl Nitrogen

Note:
1) Sampling frequency may be reduced to twice per season if the system nitrogen loading rate is less than 75% of the nitrogen permit limit (125% of crop uptake. The months in which the samples are to be taken should be specified in the permit and/or O&M manual (for example, July and September). This monitoring reduction should not be allowed for municipal systems with industrial users.

Table 7-29. Wastewater Analyses.

Parameter	Abbreviations	Units	EPA[1]	Standard Methods[2]	Comments
Total Flow	--	MGD	--	meter measurement	
pH	--	S.U.	150.1	4500-H+	
Dissolved Oxygen	DO	mg/L	360.1 or 360.2	4500-O	
Chemical Oxygen Demand	COD	mg/L	410.1 see comments	5220 B	for COD>50 mg/L & Cl < 2000 mg/L
Chemical Oxygen Demand	COD	mg/L	410.2 see comments	5220 B	for COD 5-50 mg/L
Chemical Oxygen Demand	COD	mg/L	410.3 see comments	5220 B	for COD > 250 mg/L & Cl > 1000 mg/L
Biological Oxygen demand	BOD	mg/L	405.1	5210 B	
Electrical Conductivity	EC	umhos/cm	120.1	2510 B	
Total Dissolved Solids (or Total Filterable Residue)	TDS	mg/L	160.25	2540 C5	This analysis includes both organic and inorganic TDS5
Volatile Dissolved Solids (Total Nonfilterable Dissolved Residue)	VDS	mg/L	160.45	2540 E5	See footnote #5
Fixed Dissolved Solids	FDS	mg/L		2540 E (20th Ed.)	
Non Volatile Dissolved Solids	NVDS	mg/L			Calculated by subtracting VDS from TDS[5]
Total Suspended Solids (or Total Non-Filterable Residue)	TSS	mg/L	160.1	2540 D	
Total Settleable Solids	SS	mg/L	160.5	2540 F	
Ammonia Nitrogen	NH3-N	mg/L	350.1, 350.2, or 350.3	4500-NH3	(See also AOAC4 920.03, 1990 edition)
Total Kjeldahl Nitrogen	TKN	mg/L	351.1, 351.2, 351.3, or 351.4	4500-Norg	(See also AOAC4 955.04, 1990 edition)
Nitrate + Nitrite Nitrogen	NO3 + NO2	mg/L	353.1, 353.2 or 353.3	4500-NO3 + 4500-NO2	(See also AOAC4 958.01, 1990 edition)

Parameter	Abbreviations	Units	EPA[1]	Standard Methods[2]	Comments
Total Phosphorus	P	mg/L	365.4	4500-P	(See also AOAC4 965.09, 1990 edition)
Sodium	Na	mg/L	273.1	3500-Na	(See also AOAC4 965.09, 1990 edition)
Potassium	K	mg/L	258.1	3500-K	(See also AOAC4 965.09, 1990 edition)
Calcium	Ca	mg/L	215.1 or 215.2	3500-Ca	(See also AOAC4 965.09, 1990 edition)
Magnesium	Mg	mg/L	242.1	3500-Mg	(See also AOAC4 965.09, 1990 edition)
Iron	Fe	mg/L	236.1	3500-Fe	(See also AOAC4 965.09, 1990 edition)
Manganese	Mn	mg/L	243.1	3500-Mn	(See also AOAC4 965.09, 1990 edition)
Oil & Grease	--	mg/L	413.1 or 413.2	5520	
Alkalinity	Alk	mg/L	310.1 or 310.2	2320	
Chloride	Cl	mg/L	325.1, 325.2, or 325.3	4500-Cl-	
Chlorine Residual	Clres	mg/L	330.1, 330.2, 330.3, 330.4 or 330.5	4500-Cl	
Fluoride	F	mg/L	340.1, 340.2 or 340.3	4500-F-	
Fecal Coliform	FC	#/100 ml	p. 1323 or p. 1243	9221 C 9222 D	
Total Coliform	TC	#/100 ml	p. 1143 or p. 1083	9221 B 9222 B	
Total Coliform in presence of chlorine	TC	#/100 ml	p. 1143 or p. 1113	9221 B 9222 B+B.5c	
Fecal Streptococcus	FS	#/100 ml	p. 1393, p. 1363 or p. 1433	9230 B 9230C	
Gross alpha	--	pCi/L	--	7110	
Gross beta	--	pCi/L	--	7110	
SAR	SAR	meq0.5/ L0.5	NA	NA	Calculation

Notes:

1. Methods for Chemical Analysis of Water and Wastes. Environmental Protection Agency, Environmental Monitoring Systems Laboratory-Cincinnati (EMSL-Cllll), EPA-600/4-79-020. Revised March 1983 and 1979 where applicable.
2. Greenberg, A.E. et al. (eds). 1992. Standard Methods for the Examination of Water and Wastewater - 18th Edition.
3. Bordner, R.H., and J.A. Winter, eds. 1978. "Microbiological Methods for Monitoring the Environment, Water and Waste." Environmental Monitoring Systems Laboratory, U.S. Environmental Protection Agency. EPA-600/8-78-017.
4. Association of Official Analytical Chemists, Official Methods of Analysis (AOAC). 1990 15th Edition. All methods cited in this appendix are recommended methods. Other comparable methods yielding the same interpretive results are acceptable unless otherwise stated in the Wastewater-Land Application Permit.
5. A measure of inorganic TDS in wastewater is important in order to calculate total salt loading to a site and predict down-gradient ground water concentrations. Estimates of inorganic TDS can be made by subtracting VDS from TDS to obtain Non-Volatile Dissolved Solids (NVDS). Major ions may also be summed to estimate this parameter.

7.7.9 Crop Monitoring and Yield Estimation Supplemental Information

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7.7.9.1 Crop Nutrient Concentration Values

Table 7-30 provides estimated nitrogen contents of the harvested portion of selected crops and vegetables. These values are approximate; actual site values will vary due to crop maturity, crop variety, climate (particularly water stress), and general nutrition status of crop.†

Table 7-30. Crop Nutrient Concentration Values.

		N (Dry matter basis)				N harvested‡	
Crop Description	Data Source	Common value	General range	Unit of measure	Moisture content of unit	Common value	General range
			-------- % --------			%	----lb N/unit ---
Cereal and oil crops							
Barley, grain	1	2.10	1.90-2.30	Bu	14	0.87	0.78-0.95
Straw	1	0.73	0.58-0.88	Ton	10	13	10-16
Barley	5	--	--	Bu	11	--	0.9
Barley	6	--	--	Bu	--	--	1.5 (for 100 bu/ac yield)
Corn, Grain, Shelled	1	1.55	1.35-1.75	Bu	15	0.73	0.64-0.83
Silage	1	1.25	1.10-1.45	Ton	70	7.2	6.6-8.7
Corn, Field for Grain	5	--	--	Bu	13	--	0.8
Corn, Grain	6	--	--	Bu	--	--	1.3 – 1.5 (as yield varies from 200 to 100 bu/ac
Oat, grain	1	2.20	1.95-2.50	Bu	14	0.61	0.54-0.69
Straw	1	0.70	0.55-0.85	Ton	10	13	9-15
Oats	5	--	--	Bu	11	--	0.6
Oats	6	--	--	Bu	--	--	1.5 (for 100 bu/ac yield)
Rice, grain	1	1.40	1.05-1.65	Bu	14	0.54	0.41-0.64
Straw	1	0.65	0.50-0.80	Ton	10	12	9-14
Rye, grain	1	2.20	2.00-2.40	Bu	14	1.05	0.95-1.2
Straw	1	0.50	0.35-0.65	Ton	10	9	6-12

		N (Dry matter basis)				N harvested‡	
Crop Description	Data Source	Common value	General range	Unit of measure	Moisture content of unit	Common value	General range
			-------- % --------			%	----lb N/unit ---
Sorghum, grain	1	1.65	1.45-1.80	Bu	14	0.80	0.70-0.87
Soybean, grain	1	6.50	6.10-6.90	Bu	15	3.3	3.1-3.5
Straw	1	0.85	0.70-1.00	Ton	10	15	13-18
Sunflower, seed Oil type	1	2.70	2.20-3.20	Ton	10	49	40-58
Confection	1	3.20	2.80-3.60	Ton	10	58	50-65
Wheat grain, Hard red winter	1	2.30	2.05-2.50	Bu	14	1.2	1.1-1.3
Soft red winter	1	2.10	1.85-2.30	Bu	14	1.1	0.95-1.20
Soft white winter	1	1.80	1.60-2.00	Bu	14	0.95	0.80-1.05
Hard red spring	1	2.60	2.35-2.85	Bu	14	1.35	1.20-1.50
Straw	1	0.65	0.40-0.85	Ton	10	11	7-15
Wheat	5	--	--	Bu	11	--	1.2
Wheat	6			Bu			2.32 (for 100 bu/ac yield)
Forage crops							
Alfalfa, Hay, sun-cured Vegetative	1	3.30	2.80-3.80	Ton	15	56	48-65
Early bloom	1	3.05	2.55-3.55	Ton	15	52	43-60
Mid bloom	1	2.75	2.25-3.25	Ton	15	47	38-55
Full bloom	1	2.50	2.00-3.00	Ton	15	43	34-51
Green chop Vegetative	1	3.55	3.05-4.05	Ton	75	18	15-20

		N (Dry matter basis)				N harvested‡	
Crop Description	Data Source	Common value	General range	Unit of measure	Moisture content of unit	Common value	General range
			-------- % --------			%	----lb N/unit ---
Early bloom	1	3.15	2.65-3.65	Ton	75	16	13-18
Mid bloom	1	2.90	2.40-3.40	Ton	75	15	12-17
Full bloom	1	2.60	2.10-3.10	Ton	75	13	10-16
Alfalfa Hay	5	--	--	Ton	10	--	50.4
Alfalfa, Green Chop	5	--	--	Ton	75	--	14
Alfalfa Hay	6	--	--	Ton	--	--	53.3 (for 6 ton/ac yield)
Bermudagrass Hay, sun-cured Vegetative	1	2.50	1.90-3.10	Ton	15	43	32-53
Early to mid bloom	1	1.70	1.30-2.10	Ton	15	29	22-36
Full bloom to mature	1	1.10	0.80-1.40	Ton	15	19	14-24
Green chop Vegetative	1	2.75	2.10-3.40	Ton	75	14	11-17
Early to mid bloom	1	1.90	1.40-2.40	Ton	75	10	7-12
Full bloom to mature	1	1.25	0.90-1.60	Ton	75	6	5-8
Birdsfoot trefoil Hay, early bloom	1	3.10	2.60-3.60	Ton	15	53	44-61
Mid to full bloom	1	2.20	1.90-2.50	Ton	15	37	32-43
Green chop Early bloom	1	3.20	2.70-3.70	Ton	75	16	14-19
Mid to full bloom	1	2.30	1.95-2.65	Ton	75	12	10-13
Bluegrass, Kentucky	1	1.75	1.40-2.00	Ton	15	30	24-34

		N (Dry matter basis)				N harvested‡	
Crop Description	Data Source	Common value	General range	Unit of measure	Moisture content of unit	Common value	General range
			-------- % --------			%	----lb N/unit ---
Hay, sun-cured Mid bloom							
Mature	1	1.00	0.85-1.15	Ton	15	17	15-20
Hay, green chop Mid bloom	1	2.00	1.60-2.40	Ton	75	10	8-12
Mature	1	1.05	0.90-1.20	Ton	75	5	4-6
Bluestem Early bloom	1	1.40	1.10-1.70	Ton	20	22	18-27
Full bloom	1	1.10	0.90-1.30	Ton	20	18	14-21
Mature	1	0.70	0.60-0.80	Ton	20	11	10-13
Bromegrass, smooth, Hay, sun-cured Vegetative	1	3.05	2.60-3.50	Ton	15	52	44-60
Early bloom	1	2.10	1.75-2.45	Ton	15	36	30-42
Mid to late bloom	1	1.80	1.40-2.20	Ton	15	31	24-37
Mature	1	0.95	0.80-1.10	Ton	15	16	14-19
Hay, green chop Vegetative	1	3.35	2.85-3.85	Ton	75	17	14-19
Early bloom	1	2.25	1.90-2.60	Ton	75	11	9-13
Mid to late bloom	1	1.80	1.50-2.20	Ton	75	9	8-11
Mature	1	0.95	0.80-1.10	Ton	75	5	4.6
Bromegrass	6	--	--	Ton	--	--	60 (for a 6 ton/ac yield)
Clover Alsike Hay	1	2.40	2.05-2.75	Ton	15	41	35-47

		N (Dry matter basis)				N harvested‡	
Crop Description	Data Source	Common value	General range	Unit of measure	Moisture content of unit	Common value	General range
			-------- % --------			%	----lb N/unit ---
Green chop	1	2.75	2.35-3.15	Ton	75	14	12-16
Clover Hay	2, 3	--	--	Ton	15	--	41
Crimson Hay	1	2.65	2.25-3.05	Ton	15	45	38-52
Green chop	1	2.75	2.35-3.15	Ton	75	14	12-16
Ladino Hay	1	3.50	3.00-4.00	Ton	15	60	51-68
Green chop	1	4.00	3.50-4.50	Ton	75	20	17-23
Red, hay, sun-cured Late vegetative	1	3.35	2.85-3.85	Ton	15	57	49-66
Early to mid bloom	1	2.50	2.10-2.90	Ton	15	42	36-49
Full bloom	1	2.35	1.95-2.75	Ton	15	40	33-47
Red, green chop Late vegetative	1	3.40	2.90-3.90	Ton	75	17	15-20
Early to mid bloom	1	2.60	2.20-3.00	Ton	75	14	11-15
Full bloom	1	2.40	2.00-2.80	Ton	75	12	10-14
Sweet, hay	1	2.65	2.25-3.05	Ton	15	45	38-52
Green chop	1	2.90	2.50-3.30	Ton	75	15	13-17
White, hay	1	3.40	2.90-3.90	Ton	15	58	49-66
Green chop	1	4.00	3.50-4.50	Ton	75	20	18-23
Corn, silage	1	1.25	1.10-1.45	Ton	70	7.5	6.6-8.7
Corn, silage	5	--	--	Ton	72	--	7.1

		N (Dry matter basis)				N harvested‡	
Crop Description	Data Source	Common value	General range	Unit of measure	Moisture content of unit	Common value	General range
			-------- % --------			%	----lb N/unit ---
Corn, silage	6	--	--	Ton	--	--	6.25 (for 32 ton/ac yield)
Fescue, tall Hay, late vegetative	1	2.70	2.20-3.20	Ton	15	46	37-54
Mid bloom	1	1.50	1.20-1.80	Ton	15	26	20-31
Mature	1	1.00	0.80-1.20	Ton	15	17	14-20
Green chop Late vegetative	1	2.90	2.30-3.50	Ton	75	15	12-18
Mid bloom	1	1.70	1.40-2.00	Ton	75	9	7-10
Mature	1	1.10	0.90-1.30	Ton	75	6	5-7
Fescue, tall	2, 3	--	--	Ton	15	--	46
Grass Silage	5	--	--	Ton	75	--	14
Grass Hay	6	--	--	Ton	--	--	60 (for 4 ton/ac yield)
Meadow Foxtail	6	--	--	Ton	--	--	60 (for 6 ton/ac yield)
Orchardgrass Hay, late vegetative	1	2.40	1.90-2.90	Ton	15	41	32-49
Mid bloom	1	1.60	1.30-1.90	Ton	15	27	22-32
Mature	1	1.20	1.00-1.40	Ton	15	20	17-24
Green chop Late vegetative	1	2.50	2.00-3.00	Ton	75	13	10-15
Mid bloom	1	1.70	1.40-2.00	Ton	75	9	7-10
Mature	1	1.20	1.00-1.40	Ton	75	6	5-7
Orchardgrass	2, 3	--	--	Ton	15	--	41
Orchardgrass	6	--	--	Ton	--	--	60 (for 6 ton/ac yield)

		N (Dry matter basis)				N harvested‡	
Crop Description	Data Source	Common value	General range	Unit of measure	Moisture content of unit	Common value	General range
			-------- % --------			%	----lb N/unit ---
Peanut, hay	1	1.85	1.50-2.20	Ton	15	31	26-37
Reed Canarygrass	6	--	--	Ton	--	--	60 (for 6 ton/ac yield)
Ryegrass Hay, late vegetative	1	1.85	1.50-2.20	Ton	15	31	26-37
Mid bloom	1	1.30	1.00-1.60	Ton	15	22	17-27
Green chop Late vegetate	1	2.00	1.60-2.40	Ton	75	10	8-12
Mid bloom	1	1.40	1.10-1.70	Ton	75	7	6-9
Sorghum, silage	1	1.00	0.70-1.30	Ton	74	5.2	3.5-6.8
Sorghum-sudan Green chop Immature	1	2.65	1.90-3.45	Ton	82	9.5	6.8-12
Mid-mature	1	1.40	1.00-1.80	Ton	77	6.4	4.6-8.3
Silage	1	1.50	0.95-2.05	Ton	77	6.9	4.5-9.5
Timothy Hay, sun-cured Vegetative	1	2.25	1.90-2.60	Ton	15	38	32-44
Early to mid bloom	1	1.55	1.30-1.90	Ton	15	26	22-32
Late bloom	1	1.20	1.00-1.40	Ton	15	20	17-24
Mature	1	0.95	0.80-1.10	Ton	15	16	14-19
Hay, green chop Vegetative	1	2.30	1.95-2.65	Ton	75	12	10-13
Early to mid bloom	1	1.70	1.35-2.00	Ton	75	9	7-10
Late bloom	1	1.25	1.05-1.45	Ton	75	6	5-7
Mature	1	0.95	0.80-1.10	Ton	75	5	4-6

		N (Dry matter basis)				N harvested‡	
Crop Description	Data Source	Common value	General range	Unit of measure	Moisture content of unit	Common value	General range
			-------- % --------			%	----lb N/unit ---
Vetch Common Hay, early bloom	1	3.60	3.10-4.10	Ton	15	61	53-70
Full bloom	1	2.90	2.50-3.30	Ton	15	49	43-56
Green chop Early bloom	1	3.70	3.10-4.20	Ton	75	19	16-21
Full bloom	1	3.00	2.60-3.40	Ton	75	15	13-17
Hairy fresh Mid bloom	1	3.70	3.10-4.20	Ton	75	19	16-21
Wheatgrass, crested Hay, early bloom	1	1.60	1.30-1.90	Ton	20	26	21-30
Full bloom	1	1.40	1.10-1.70	Ton	20	22	18-27
Mature	1	0.60	0.50-0.70	Ton	20	10	8-11
Wheatgrass, crested	2, 3	--	--	Ton	20	--	26
Fiber and miscellaneous crops							
Flax, seed	1	3.80	3.30-4.30	100 lb (1 cwt)	7	3.5	3.1-4.0
Hay	1	1.85	1.50-2.20	Ton	15	31	26-37
Potato, white tubers	1	1.60	1.20-1.90	100 lb (1 cwt)	75	0.4	0.3-0.5
Potato	6	--	--	100 lb (1 cwt)	--	--	0.55 (for a 400 cwt yield)
Rangeland	5	--	--	--	--	--	24
Sugarbeet Tops w/crown	1	2.10	1.80-2.30	--	82	7.6	6.5-8.3

		N (Dry matter basis)				N harvested‡	
Crop Description	Data Source	Common value	General range	Unit of measure	Moisture content of unit	Common value	General range
			-------- % --------			%	----lb N/unit ---
Roots w/o crown	1	0.80	0.60-0.95	Ton	77	3.7	2.8-4.4
Tops w/o crown	1	2.50	2.20-2.80	Ton	82	9.0	7.9-10.1
Roots w/crown	1	1.10	0.90-1.30	Ton	77	5.1	4.1-6.0
Sunflower, seed Oil type	1	2.70	2.20-3.20	Ton	10	49	40-58
Confection	1	3.20	2.80-3.60	Ton	10	58	50-65
Trees	4						80 - 220
Vegetable crops							
Bean, snap, pods	1	3.00	2.50-3.50	Ton	87	7.8	6.5-9.0
Dry bean seed	1	4.00	3.50-4.50	100 lb (1 cwt)	10	3.6	3.2-4.1
Tops	1	3.50	3.00-4.00	Ton	85	11	9-13
Onion, bulbs	1	2.20	1.90-2.50	Ton	90	4.4	3.8-5.0
Pea, seed only	1	4.20	3.50-4.70	Ton	80	17	14-19
Vine-no pods	1	2.00	1.50-2.50	Ton	75	10	8-13
Pepper, sweet green	1	2.30	1.90-2.70	Ton	92	3.7	3.0-4.3
Squash, summer	1	3.10	2.70-3.50	Ton	92	5.0	4.3-5.6
Winter	1	2.10	1.70-2.50	Ton	88	5.0	4.1-6.0
Sweet corn, stover	1	1.30	1.10-1.50	Ton	70	7.8	6.6-9.0
Ears with husks	1	1.60	1.40-1.80	Ton	73	8.6	7.6-9.7
Sweet potato, root	1	1.10	0.90-1.30	Ton	72	6.2	5.0-7.3

		N (Dry matter basis)				N harvested‡	
Crop Description	Data Source	Common value	General range	Unit of measure	Moisture content of unit	Common value	General range
			-------- % --------			%	----lb N/unit ---
Tomato	1	2.70	2.30-3.10	Ton	94	3.2	2.8-3.7
Tree and fruit crops							
Apple	1	0.35	0.25-0.45	Ton	82	1.3	0.9-1.6
Almond, with shell	1	3.30	3.00-3.60	Ton	15	56	51-61
Cherry	1	1.15	1.00-1.30	Ton	82	4.1	3.6-4.7
Grape	1	0.60	0.50-0.70	Ton	80	2.4	2.0-2.8
Peach	1	1.00	0.80-1.20	Ton	88	2.4	1.9-2.9
Pear	1	0.40	0.30-0.50	Ton	82	1.4	1.1-1.8
Pecan, with shell	1	2.80	2.50-3.10	Ton	15	48	43-53
Strawberry	1	1.35	1.10-1.60	Ton	91	2.4	2.0-2.9

†Percent N and N harvested will generally be above the common value for crops grown on N-rich soils (luxury amounts of manure, fertilizer, etc.) and for crops grown in water-stress conditions (low dry matter production); percent N and harvested N will generally be below the common value for crops grown in N poor soils (low N inputs (and for crops with above-average dry matter production (good rainfall years, irrigation, etc.)

‡CHh as defined in Chapter 12 by Pierce et al., is the N removed in the harvested biomass.

Data Sources:
1) Follett et al. 1991;
2) Fonnesbeck et al., 1984;
3) Part 651, Agricultural Waste Management Field Handbook
4) From various references for poplars, other deciduous trees, conifers, and woodlands; Note: Alternative uptake values provided by a qualified silviculturist are acceptable.
5) 1992 Census of Agriculture, refer to the following website: http://www.nhq.nrcs.usda.gov/land/pubs/nlapp1a.html
6) DEQ 1988 WLAP Guidelines. Adapted from Kelling, K.A., and A.E. Peterson and the Land-Applied Wastewater Technical Advisory Committee

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Part B: High Rate Land Treatment of Wastewater

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9. Rapid Infiltration Land Application Permitting Guidance

In 1996, the *Interpretive Supplement* was published within a comprehensive guidance document entitled *Handbook for Land Application of Municipal and Industrial Wastewater*. Guidelines were established for slow rate land application systems. Rapid infiltration (RI) systems are allowed under the *Wastewater Land Application Rules*, but with the promulgation of the *Ground Water Quality Rule* and other technical questions, additional guidance is needed to assist permit writers and the regulated community in understanding criteria for designing and permitting rapid infiltration systems.

9.1 Guidance and Regulations for Rapid Infiltration

EPA identified rapid infiltration systems in the mid-70s, as effective alternative treatment for municipal wastewater. Design criteria and methods are presented in the U. S. Environmental Protection Agency (EPA) documents, *Process Design Manual: Land Treatment of Municipal Wastewater*, 1981, and *Process Design Manual: Land Treatment of Municipal Wastewater, Supplement on Rapid Infiltration and Overland Flow, 1984*. These documents have generally been applied in designs for Idaho rapid infiltration systems.

From the *Wastewater-Land Application Permit Rules* (IDAPA 58.01.17), Rapid Infiltration Systems are to be permitted:

- 200.15. Definition: Rapid Infiltration System. A wastewater treatment method by which wastewater is applied to land in an amount of twenty (20) to six hundred (600) feet per year for percolation through the soil. Vegetation is not generally utilized by this method. (4-1-88)
- 600.06. Rapid Infiltration Systems. The following minimum treatment requirements are established for land application of wastewater. (4-1-88)

  a. Suspended solids content of wastewater, which includes organic and inorganic particulate matter shall not exceed a thirty (30) day average concentration of one hundred (100) mg/l. (4-1-88)

  b. Nitrogen (total as N) content of wastewater shall not exceed a thirty (30) day average concentration of twenty (20) mg/l. (4-1-88)

9.2 Site Specific Permitting Considerations

There are three (3) ground water/surface water scenarios encountered when considering the regulation of rapid infiltration systems.

Scenario 1: Rapid infiltration systems having surface water impacts only. These systems are generally found very close to natural surface waters. Any local ground water discharges to the surface water entirely. There are no ground water uses between the basin and the receiving water. *Water Quality Standards and Wastewater Treatment Requirements*, IDAPA 58.01.02, apply. A *National Pollutant Discharge Elimination System* (NPDES) permit would be the most appropriate permitting mechanism. If EPA is unable or unwilling to issue a NPDES permit, a *Wastewater Land Application Permit* should be issued that adequately protects the surface water. Consideration should be given to surface water monitoring upstream and downstream for parameters of concern, vadose zone monitoring to determine degree of treatment, and monitoring the wastewater as it enters the basin.

Scenario 2: Rapid Infiltration systems having ground water impacts only. Most ground water eventually discharges to surface water, however, if the affected surface water is more than 1,320 feet from the rapid infiltration system, the system would be assumed to have ground water influences only and be included in this scenario. Additionally, if there is any diversion or reasonable potential diversion of the ground water, it would be included in this scenario. In this case, the *Ground Water Quality Rule*, IDAPA 58.01.11, governs the impacts to the ground water. A Wastewater Land Application Permit should be issued. Ground water monitoring wells are required to determine impacts.

Scenario 3: Rapid Infiltration systems impacting both ground water and surface water. In this scenario it may be necessary to issue an NPDES permit and a Wastewater Land Application Permit. Elements of Scenario 1 and Scenario 2 would be incorporated into the Wastewater Land Application Permit and NPDES permits. If EPA issues an NPDES permit, it may be possible to include monitoring and permit limits for ground water concerns in the NPDES permit.

Existing facilities: Certain existing facilities that have NPDES permits were not required to obtain a Wastewater Land Application Permit. These facilities should be evaluated to determine which Scenario would be appropriate. If they are determined to be Scenario 1, DEQ will rely on the NPDES Permit process. Most likely these facilities would not be Scenario 2 since an NPDES permit presumes some surface water impact, but they might fall into the Scenario 3 scenario. If this is the case, the facility is required to obtain a Wastewater Land Application Permit unless the NPDES permit can be modified to satisfy wastewater land application issues. Since there is some time required for application preparation, permit processing, and construction, a consent order may be the appropriate mechanism to enable the facility to evaluate their situation and comply with the regulations. The Director may issue a waiver to the facility to exempt them from obtaining a Wastewater Land Application Permit, as provided in the Act.

9.3 References

Environmental Protection Agency. October 1981. Process Design Manual - Land Treatment of Municipal Wastewater, 625/1-81-013.

Environmental Protection Agency. October 1984. EPA Process Design Manual; Land Treatment of Municipal Wastewater - Supplement on Rapid Infiltration and Overland Flow. EPA 625/1-81-013a.

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Part C: Other Reuse

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12. Other Regulatory Requirements Associated With Wastewater Land Application Facilities

This handbook focuses on applying wastewater to the land surface and the permit program that manages this land use activity. However, while issuance of a wastewater-land application permit is essential, it is also important for permittees and their consultants to be aware of other relevant environmental considerations associated with a given wastewater-land application site and system to knowledgeably plan and anticipate issues of concern.

An overview of the "big environmental picture" associated with a land application system involves many interrelated issues, such as protection of public health and public safety, prevention and resolution of nuisances, protection of ground water quality, and conservation of ground and surface water supplies to name a few. Most issues or potential sources of contamination are managed by programs that may either be: (1) regulatory, or those based on numerical standards, narrative standards, rules, permits or other mandated features, or (2) non-regulatory, or those based on guidance, management strategies, education and technical assistance or other voluntary efforts suited to the potential source(s) of contamination.

The wastewater-land application permit is just one of several that need to be considered by each company before doing business in Idaho. In addition to the wastewater-land application permit, each permittee should consider the full complement of applicable state and local rules and regulations for the jurisdiction in which their wastewater-land application facility is located. While the Department of Environmental Quality (DEQ) wastewater-land application permit assures the WLAP permittee that the wastewater-land application treatment system has been approved for operation, the WLAP permit is not intended to imply compliance with other local and state rules or regulations.

A list of relevant environmental considerations has been compiled as an informational tool for the WLAP applicant and permittee. This list includes local, state and federal requirements and is not intended to be exhaustive for every location in the state or to distinguish which requirements apply to new facilities versus modifications on existing facilities, but rather provides general information to help direct the permittee to the appropriate contact agencies.

12.1 Domestic Sewage Disposal

Sanitary wastes or domestic sewage wastes generated by a facility can be included with the industrial waste stream and land applied. If combined with industrial wastewater, the sanitary wastes must be addressed as part of the wastewater-land application system permit. Combined sanitary and industrial waste streams typically have to meet the buffer zone distances for municipal wastewater.

If the sanitary wastes are disposed of separately from the wastewater-land application treatment system, then the method of treatment determines the contact agency. If an individual or community subsurface sewage disposal system (septic tank/drainfield) is the treatment method of choice, then the local District Health Department should be contacted for permitting requirements. Application must also be made and a replacement permit issued by the District Health Department in the event of a subsurface sewage system failure.

If an above ground sewage disposal system, such as a lagoon or connection into a municipal sewage plant, is the treatment method of choice, then DEQ should be contacted.

12.2 Plan and Specification Reviews

Idaho Code 39-118 states that all plans and specifications for the construction of new sewage systems, sewage treatment plants or systems, other waste treatment or disposal facilities, public water supply systems or public water treatment systems or for modification or expansion to existing sewage treatment plants or systems, waste treatment or disposal facilities, public water supply systems or public water treatment systems, shall be submitted to and approved by DEQ before construction begins. This review can be coordinated through the land application permit process for new systems.

12.3 Non-Contact Cooling Water

The Wastewater-Land Application Permit Regulations' definition for wastewater (IDAPA 58.01.17.200.19) specifically excludes non-contact cooling water as a component of wastewater and as such, non contact cooling water is not included in the wastewater loading conditions of the WLAP permit. However, a permit to discharge non-contact cooling water to surface water is required by the *National Pollutant Discharge Elimination System* (NPDES) Program administered by EPA. Non-contact cooling water may be used as a supplemental source of irrigation water and as such may be applied to some or all of the same fields as the wastewater is being land applied. Non-contact cooling water may also be discharged into shallow or deep underground injection wells in accordance with the *Rules for Construction and Use of Injection Wells* as administered by the Department of Water Resources (IDAPA 37.03.03).

12.4 Water Appropriations and Allocations

Long term use of water supplies requires receipt of specific water rights from the Idaho Department of Water Resources. Water rights should be obtained for every domestic or irrigation well. Established water rights may benefit a facility or permittee, particularly if competing uses for the same water becomes an issue at some point in time. If irrigation water is derived from a reservoir and canal (surface water) system rather than ground water wells, then the water rights reside with the owner or owners' designee for a privately owned surface water system or, with the Bureau of Reclamation for a federal reclamation irrigation project. The Bureau of Reclamation or private owner contracts with the irrigation district(s) for the water stored in the reservoir and the irrigation districts then contracts with individual property owners. Magic Reservoir or Mackay Reservoir are two examples of privately owned reservoir systems, while Cascade Reservoir is an example of a federally administered project.

Many wastewater-land application sites and systems also need a source of fresh water to supplement the wastewater being applied for crop production. If supplemental water is needed for the system, then documentation of an established water right should be submitted with the wastewater-land application permit application.

12.5 Disposal of Truck Wash Sand & Grit Sumps, Grease Traps and Other Miscellaneous Small Volume Waste/Wastewater

Wastes generated by truck washing operations or maintenance shops typically originate from sand and grit sumps, which need periodic cleaning and disposal. Likewise, grease and other floatable wastes are often separated from the main waste stream and collected in a grease trap, which needs routine maintenance and cleaning. This type of small volume waste may be addressed as part of the wastewater land application permit if desired by the permittee. When combined as part of the wastewater land application permit, the permittee is responsible for submitting pertinent information on any miscellaneous small volume waste or wastewater as part of the WLAP permit application materials to DEQ.

If the miscellaneous small volume waste/wastewater is disposed of separately from the wastewater-land application treatment system, then often those wastes are physically pumped from some type of holding area into a watertight tank truck or equivalent and transported to a location off site approved for treatment and disposal.

12.6 Sludge Management

Municipal sludge must be managed according to 40 CFR Part 503-*Standards for the Use and Disposal of Sewage Sludge*. Requirements reflecting these rules are a part of every NPDES permit issued by EPA to a publicly owned wastewater treatment plant. Municipalities should be in contact with DEQ for approval of sludge treatment and disposal methods.

Industrial sludge is exempted from the requirements of 40 CFR Part 503. Instead, industrial sludge is managed in accordance with the *Water Quality Standards and Wastewater Treatment Requirements* (IDAPA 58.01.02.650) administered by DEQ or by the District Health Departments if the industrial sludge meets the definition of a non municipal solid waste.

12.7 Discharges to Surface Waters

The National Pollutant Discharge Elimination System (NPDES) program was established by Section 402 of the Clean Water Act. An NPDES permit is required for any direct discharge to surface (navigable) waters of the state or waters of the United States from new or existing sources.

Since EPA has permitting authority for the NPDES program in Idaho, the EPA Idaho Operations Office in Boise should be contacted for permitting information on any type of point source discharge from a facility. EPA then coordinates with DEQ for regional input on each NPDES permit issued.

12.8 Designated Special Resource Waters or Sole Source Drinking Water Aquifers

On January 1, 1995, the Spokane Valley-Rathdrum Prairie Aquifer was designated as a special resource *ground* water in Idaho. A special guidance document has been developed that has specific recommendations for wastewater-land application treatment systems on this aquifer. The *Special Supplemental Guidelines for Spokane Valley-Rathdrum Prairie Aquifer Wastewater Land Application* can be found in the appendix. This guidance is intended to work in conjunction with the Wastewater-Land Application Permit Regulations and other guidance Editors note: If there is inconsistency, we ought to fix it before the web version comes out.

Existing permitted facilities, or entities anticipating applying for a WLAP permit that will be located over the Spokane-Valley Rathdrum Prairie Aquifer, should direct questions to DEQ's North Idaho Regional Office in Coeur d'Alene at (208) 769-1422.

12.9 Ongoing Education

To maximize ground water protection while achieving and maintaining the most efficient and cost effective wastewater-land application treatment system requires ongoing education. It is important that the public and regulated community is informed about the reasons for preventing contamination, the activities of a land application system that may lead to ground water contamination and ways to prevent ground water contamination from a specific and unique land application site. An informed public and regulated community are more likely to work together to prevent contamination voluntarily and without the need for as much regulatory oversight.

Participating in educational opportunities should help to inform and enhance networking for both industry and the state. Currently, classes and conferences on issues related to the land application of wastewater are available from a variety of sources, including DEQ and as well as contractors. Other educational opportunities exist through the individual or joint efforts of DEQ and the regulated community such as bringing technical expert(s) in periodically to teach classes or seminars on Land Application of Wastewater or related topics such as how land application activities can impact ground water or finding the balance between resource protection, economic development and societal needs.

12.10 Reference

Idaho Division of Environmental Quality. January 1995. Special Supplemental Guidelines: Spokane Valley-Rathdrum Prairie Aquifer Wastewater Land Application. 18 pages.

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Glossary

Term	Definition
Aerosol	A gaseous suspension of fine solid or liquid particles.
Agricultural Activity/Agriculture	Any activity conducted on land or water for the purpose of producing an agricultural commodity, including crops, livestock, trees, and fish.
Agronomic Rate	The application rate of nutrients and moisture required to achieve anticipated or documented crop yields for a specific region. The agronomic rate may be estimated by published information or determined from actual field measurements.
Agronomic Uptake	The amount of nutrients or salts harvested from a land application field or system.
Applicable Requirements	Any state, local or federal statutes, regulations or ordinances to which the facility is subject.
Aquic	Saturated at least part of the time; reducing conditions in the soil prevail.
Aquifer	"A geological unit of permeable saturated material capable of yielding economically significant quantities of water to wells and springs."(IDAPA 58.01.11.007.02)
Aridic	Soil dry most of the time.
Available Water Capacity	Moisture content of soil between field capacity and wilting point that is available for crop use. Use soil survey or site specific information to determine.
Bacteria	A group of universally distributed, rigid, essentially unicellular microorganisms. Bacteria usually appear as spheroid, rodlike or curved entities, but occasionally appear as sheets, chains, or branched filaments.
Beneficial Use	Any of the various uses which may be made of the water of Idaho, including, but not limited to, domestic water supplies, industrial water supplies, agricultural water supplies, navigation, recreation in and on the water, wildlife habitat, and aesthetics. The bendficial use is dependent upon actual use, the ability of the water to support a non-existing use either now or in the future, and its likelihood of being used in a given manner. The use of water for the purpose of wastewater dilution or as a receiving water for a waste treatment facility effluent is not a beneficial use.
Beneficial Uses of Ground Water	Various uses of ground water in Idaho including, but not limited to, domestic water supplies, industrial water supplies, agricultural water supplies, aquacultural water supplies and mining. A beneficial use is defined by actual current uses or future uses of the ground water.

Best Available Method	Any system, process, or method which is available to the public for commercial or private use to minimize the impact of point and nonpoint source contaminants on ground water quality.
Best Management Practice	A practice or combination of practices determined to be the most effective and practical means of preventing or reducing contamination to ground water and/or surface water from nonpoint and point sources to achieve water quality goals and protect the beneficial uses of the water.
Best Practical Method	Any system, process, or method that is established and in routine use which could be used to minimize the impact of point or nonpoint sources of contamination on ground water quality.
Board	The Idaho Board of Environmental Quality.
Buffer Zone	An area around the perimeter of a land treatment field that will provide an adequate separation distance which will reduce the potential for aesthetic and public health impacts.
Calcareous	Consisting of or containing calcium carbonate (CaCO3).
Capture Zone	A capture zone, or zone of contribution as it is sometimes called, is the area surrounding a pumping well that encompasses all areas and land use activities that supply ground water recharge to the well (EPA 1991).
Carryover Soil Moisture	Moisture stored in soils within root zone depths during the winter, at times when the crop is dormant, or before the crop is planted. This moisture is available to help meet the consumptive water needs of the crop.
Chemical Oxygen Demand (COD)	A measure of the oxygen-consuming capacity of inorganic and organic matter present in water or wastewater. It is expressed as the amount of oxygen consumed from a chemical oxidant in a specific test. It does not differentiate between stable and unstable organic matter and thus does not necessarily correlate with biochemical oxygen demand.
Coagulation	In water and wastewater treatment, the destabilization and initial aggregation of colloidal, finely divided suspended matter and/or bacterial cells by the addition of a floc-forming chemical or by biological processes.
Coliform-group Bacteria	A group of bacteria predominantly inhabiting the intestines of man or animal, but also found in nature. It includes all aerobic and facultative anaerobic, gram-negative, nonspore-forming bacilli that ferment lactose with production of gas. This group of "total" coliforms includes E. Coli which is considered the typical coliform of fecal origin.
Confined Aquifer	A geological formation in which water is isolated from the atmosphere by an overlying less permeable geologic formation. Confined ground water is generally subject to pressure greater than atmospheric; thus, the water level rises above the top of the aquifer.
Consumptive Irrigation Requirement	The depth of irrigation water, exclusive of precipitation, stored soil moisture, or ground water, that is required consumptively for crop production.

Consumptive Use	Consumptive use, often called evapo-transpiration is the amount of water used by the vegetative growth of a given area in transpiration and building of plant tissue and that evaporated from adjacent soil or intercepted precipitation on the plant foliage in any specified time. If the unit of time is small, consumptive use is usually expressed as acre inches per acre or depth in inches, whereas, if the unit of time is large, such as a growing season or a 12-month period, it is usually expressed as acre feet per acre or depth in feet.
Consumptive Water Requirement	The amount of water potentially required to meet the evapo-transpiration needs of vegetative areas so that plant production is not limited from lack of water.
Contamination	The direct or indirect introduction into ground water of any contaminant caused in whole or in part by human activities.
Crop Root Zone	The zone that extends from the surface of the soil to the depth of the deepest crop root and is specific to a species of plant, group of plants or crop.
Denitrification	The reduction of oxidized nitrogen compounds (such as nitrates) to nitrogen gas.
DEQ	The Idaho Department of Environmental Quality
Director	The Director of the Department of Health and Welfare or the Director's designee.
Disinfected Wastewater	Wastewater in which pathogenic organisms have been destroyed by chemical, physical or biological means.
Downgradient Boundary	The boundary where wastewater-land application ceases perpendicular to the flow of ground water beneath the wastewater-land application site.
Effective Rainfall	Precipitation falling during the growing period of the crop that is available to meet the consumptive water requirements of crops. It does not include such precipitation as is lost to deep percolation below the root zone nor to surface runoff.
Effluent	Wastewater or other liquid, treated or untreated, flowing from a reservoir, basin, treatment plant or part thereof.
Evaporation Rate	The quantity of water evaporated from a given water surface per unit of time. It is usually expressed in millimeters (inches) depth per day, month or year.
Fault	A break or fracture in the earths crust along which, relative movement of rocks on either side of the plane of the fracture has occurred.
Field Capacity	The moisture percentage, on a dry weight basis, of a soil after rapid drainage has taken place following an application of water, provided there is no water table within capillary reach of the root zone. This moisture percentage usually is reached within two to four days after an irrigation, the time interval depending on the physical characteristics of the soil.

Filtration	The process of passing a liquid through a filtering medium (which may consist of granular material, such as activated carbon, sand, magnetite, diatomaceous earth, finely woven cloth, unglazed porcelain or specially prepared paper) for the removal of suspended or colloidal matter.
Flocculation	In water and wastewater treatment, the agglomeration of colloidal and finely divided suspended matter after coagulation by gentle stirring by either mechanical or hydraulic means. In biological wastewater treatment where coagulation is not used, agglomeration may be accomplished biologically.
Flood Irrigation	Irrigating soils by means of surface application of water in basins.
Food Crops	Any crops intended for human consumption.
Frozen Soil	0o C or less in the upper 6 inches of soil.
Ground Water	(1) Water that occurs in a saturated zone of variable thickness, areal extent and depth below the earth's surface. (2) Any water of the state which occurs beneath the surface of the earth in a saturated geological formation of rock or soil. "Any water of the state which occurs beneath the surface of the earth in a saturated geological formation of rock or soil" (IDAPA 58.01.11.007.15).
Ground Water Compliance	A collection of environmental monitoring sites typically identified as the downgradient boundary of the area that wastewater is physically being applied to or as identified by DEQ on a case-by-case basis. The collection of monitoring points is where biological, chemical and radiological parameters must comply with appropriate water quality standards.
Growing Season	That period of time during the year when climatic factors are typically conductive to crop growth, and a crop is normally planted, cultivated and harvested.
Hazardous Waste	A material or combination of materials, which, because of its quantity, concentration or characteristics (physical, chemical or biological), presents an actual or potential hazard to human health or the environment if not properly treated, stored, disposed of or managed.
Heavy Metals	Metals which exist naturally or can be introduced to the earth and water which can adversely affect human health and the environment. Includes, but not limited to arsenic, barium, cadmium, chromium, copper, iron, lead, manganese, selenium, silver and zinc.
Hydraulic Loading	The amount of water applied to the land surface.
Hydraulic Loading Rate	The rate at which water, whether supplemental irrigation water or wastewater, is applied to a wastewater-land application site. Precipitation, although included in water balance calculations, is not considered to be an applied hydraulic load.
Industrial Effluent	Any wastewater discharged from an industrial treatment facility that does not contain sanitary waters.
Infiltration	The process whereby a liquid enters the soil or other filtering medium.

Infiltration Capacity	The flux of water which the soil profile can absorb through its surface when it is maintained in contact with water at atmospheric pressure.
Irrigation Efficiency	The percentage of applied irrigation water that is stored in the and available for consumptive use by the crop. When the water is measured at the headgate, it is called farm-irrigation efficiency; when measured at the field, it is gnated as field-irrigation efficiency; and when measured at the point of diversion, it be called project-efficiency.
Irrigation Water Requirement	The net irrigation water requirement divided by the irrigation efficiency.
Land Application Facility or Facility	Any structure or system designed or used to treat wastewater through application to the land surface.
Leaching Requirement	The fraction of the irrigation water that must be leached through the root zone to control soil salinity at any specified level.
Loading	The amount of organic matter, water, and nutrients applied to land in wastewater. See Nutrient Loading.
Municipal Wastewater	Wastewater that contains sewage.
Net Irrigation	The amount of irrigation water that is delivered to a land application site after all application losses are considered. Application losses include wind drift and evaporation. This does not consider evapotranspiration.
Net Irrigation Requirement	The depth of irrigation water, exclusive of precipitation, stored soil moisture, or ground water, that is required consumptively for crop production and required for other related uses. Such uses may include water required for leaching, frost protection, etc.
New Activity	Any significant change in operation or construction of the wastewater treatment system which may impact the waters of the state.
Non Public Drinking Water System (Well)	Includes an individual domestic well, or any domestic well that serves 2 through 14 connections or less than 25 people. It is any system that is not defined as a public drinking water system.
Non-Contact Cooling Water	Water used to reduce temperature which does not come into direct contact with any raw material, intermediate product, waste product (other than heat) or finished product.
Non-Growing Season	That period of time during the year when climatic factors are typically not conductive to crop growth, and a crop is not normally planted, cultivated or harvested.
Nutrient Loading	The amount of plant nutrients applied to soil in wastes, either solid or liquid.
Nutrient Loading Rate	The rate at which nutrients, such as nitrogen, potassium and phosphorus, are applied to a wastewater-land application site.

Overland Flow	A method of wastewater treatment by land application where wastewater is applied to gently sloping, relatively impermeable soils planted with vegetation. Treatment is accomplished by physical, chemical and biological processes as the wastewater flows through the vegetative cover.
Pathogen	A causative agent of disease.
Peak Period Consumptive Use	Peak period consumptive use is the average daily rate of use of a crop occurring during a period between normal irritations when such rate of use is at a maximum.
Percolation	The flow or trickling of a liquid downward through a contact or filtering medium. The liquid may or may not fill the pores of the medium.
Permeability	Also known as Hydraulic Conductivity, it is the capacity of a porous medium to transmit water. It is expressed as the volume of water that will move in unit time under a unit hydraulic gradient through a unit area measured at right angles to the direction of flow.
Permit	Written authorization by the Director to land apply or discharge wastewater, other than to surface waters of the state, as identified in the plan of operation.
Person	An individual, corporation, partnership, association, state, municipality, commission, political subdivision of the state, state agency, federal agency, special district, or interstate body.
Pesticides	Chemicals used to destroy specific organisms that cause disease, hinder food production or affect other commercial activities. The most widely used pesticides are synthetic compounds derived from petrochemicals and include insecticides, herbicides and fungicides.
pH	"Power of the Hydrogen Ion" (S. Sorenson, 1909). Defined as the negative logarithm of the hydrogen ion concentration: $pH = -Log10[H+]$. Hydrogen ion concentration is expressed in moles/liter (i.e. M). (M&H)
Political Subdivision	The state of Idaho, or any corporation, instrumentality or other agency thereof, or any incorporated city, or any county, school district, water and/or sewer district, drainage district, special purpose district or other corporate district constituting a political subdivision of the state, any quasi-municipal corporation, housing authority, urban renewal authority, other type of authority, any college or university, or any other body corporate and political of the state of Idaho, but excluding the federal government. (Idaho Code).
Pollution	The presence in a body of water (or soil or air) of a substance in such quantities that it impairs the water's usefulness or renders it offensive to the senses of sight, taste or smell. In general, a public health hazard may be created, but in some instances, only economic or aesthetics are involved as when waste salt brines contaminate surface waters or when foul odors pollute the air. (definition from Glossary 1)
Pretreatment	Any process or activity conducted for the purpose of removing or reducing wastewater constituents prior to or in preparation for ultimate treatment.

Primary Effluent	Raw wastewater that has been mechanically treated by screening, degritting, sedimentation and/or skimming processes to remove substantially all floatable and settleable solids.
Primary Treatment	Wastewater treatment processes or methods that serve as the first stage of treatment intended for removal of suspended and settleable solids by gravity sedimentation providing no changes in dissolved or colloidal matter.
Process Food Crop	Any crop intended for human consumption that has been changed from its original form and further disinfection occurs.
Public Drinking Water System (Well)	Includes wells supplying 15 or more connections or 25 or more individuals daily for at least 60 days out of the year. Public drinking water supply wells are identified as either Community Systems or Transient or Non-Transient Non Community Systems depending on whether individuals are served regularly more than or less than 6 months of the year.
Rapid Infiltration	A method of wastewater treatment by land application where wastewater is applied to relatively permeable soils allowing a high rate of infiltration and treatment of larger volumes of water over a small land surface area. Treatment is accomplished by physical, chemical and biological processes as the water percolates through the soil profile.
Rapid Infiltration System	A wastewater treatment method by which wastewater is applied to land in an amount of twenty (20) to six hundred (600) feet per year for percolation through the soil. Vegetation is not generally utilized by this method.
Raw Food Crop	(1) Any crop intended for human consumption which is to be used in its original form. (2) Any food crop which is not processed or undergoes minimal processing prior to human consumption.
Restricted Public Access	Preventing public entry within one thousand (1,000) feet of the border of a facility by site location or physical structures such as fencing. A buffer strip less than one thousand (1,000) feet may be accepted if aerosol drift is reduced.
Rural Area/Industrial Area	An area whose land use is predominantly rural or industrial, having scattered inhabited dwellings.
Saline	A nonsodic (nonsodium) soil containing sufficient soluble salts to impair its productivity.
Saturated Zone	A zone or layer beneath the earths surface in which the interconnected pore spaces of rock and sediments are filled with water.
Sewage	The water-carried human wastes from residences, buildings, industrial establishments and other places.
Slow Rate Irrigation	A method or wastewater treatment by land application which involves controlled distribution of wastewater to the land surface by spraying or surface spreading to support plant growth. Treatment is accomplished through physical, chemical and biological processes occurring in the plant/soil matrix.
Sludge	The semi-liquid mass produced by treatment of water or wastewater.

Sodium Adsorption Ratio (SAR)	An expression of the degree to which sodium will be adsorbed by soils from a solution in equilibrium with the soil. As the SAR increases above 10, soil permeability decreases.
Spray Irrigation	A means of wastewater application by spraying it from orifices in piping.
Subsurface Irrigation	A planned irrigation system which provides for the efficient distribution of irrigation water below the surface of the ground without causing erosion or water loss. Some examples include, low pressure, trickle application below ground surface, underground pressurized pipelines, or controllable seepage based on limiting crop and depth to ground water. (USDA SCS FOTG, 430, 441, & 443).
Suburban/Residential Area	An area whose land use is predominantly suburban or residential. An otherwise rural or industrial area having a housing subdivision in close proximity to the WLAP site would be classed as a suburban/residential area.
Surface Irrigation	Application of water by means other than spraying such that no aerosols are produced.
Suspended Solids	(1) Solids that are in water, wastewater or other liquids, and which are largely removable by laboratory filtering. (2) The quantity of material removed from wastewater in a laboratory test, as prescribed in Standard Methods for the Examination of Water and Wastewater, American Public Health Association, Washington, DC, and referred to as nonfilterable residue.
Time Distribution of Flows	A measurement of the volume of wastewater distributed over a specified area during a specified time period. Typical unit of measure is inches per acre per week.
Total Dissolved Solids (TDS)	(1a) The total concentration of dissolved constituents in solution, usually expressed in milligrams per liter. (1b) The total concentration of dissolved material in water [as] ordinarily determined from the weight of the dry residue remaining after evaporation of the volatile portion of an aliquot of the water sample (Hem, 1985). (1c) The total dissolved (filterable) solids as determined by use of the method specified in Appendix I "Wastewater Analysis". (USGS, 1989. Federal Glossary of selected terms; subsurface; Water Flow and Solute Transportation. Department of the Interior). (2) A measure of inorganic TDS in wastewater is important in order to calculate total salt loading to a site and predict down-gradient ground water concentrations. Estimates of inorganic TDS can be made by subtracting VDS from TDS to obtain Non-Volatile Dissolved Solids (NVDS). Major ions may also be summed to estimate this parameter.
Total Kjeldahl Nitrogen (TKN)	The nitrogen content of a material that is analyzed by a Kjeldahl method. This method measures the sum of free ammonia plus organic nitrogen.
Udic	Soil moist, but not wet, most of the time.
Vadose Zone	The unsaturated area above the water table.
Wastewater	Unless otherwise specified, industrial waste, municipal waste, agricultural waste, and associated solids or combinations of these, whether treated or untreated, together with such water as is present but not including sludge, or non-contact cooling water.

Wastewater Treatment System	All phases of wastewater treatment including any pretreatment equipment and the land application facility.
Water Table	The upper surface of ground water or that level below which the soil is saturated with water.
Waters and Waters of the State	All the accumulations of water, surface and underground, natural and artificial, public and private, or parts thereof which are wholly or partially within, which flow through or border upon the state.
Wellhead	The physical structure, facility, or device at the land surface from or through which ground water flows or is pumped from subsurface, water-bearing formations.
Wellhead Protection Area	The surface and subsurface area surrounding a wellhead or well field, supplying a public water system, through which contaminants are reasonably likely to move toward and reach such water well or well field.
Wellhead Setback Area	An area immediately surrounding a wellhead in which potential sources of contamination are controlled or restricted.
Wilting Point	The wilting point is the moisture percentage, also on a dry weight basis, at which plants can no longer obtain sufficient moisture to satisfy moisture requirements and will wilt permanently unless moisture is added to the soil profile.
Xeric	Mediterranean: Wet winters, dry summers.

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A Appendix

A.1 Consumptive Use and Cropping Season Table

Note: Consumptive Use data has been omitted from this table. Sources of more accurate values by crop type for the historic period of record (pre-1983) for a particular weather station may be obtained from the following web site:

http://www.kimberly.uidaho.edu/water/appndxet/index.shtml

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Table A-1. Consumptive Use and Cropping Season Table

Idaho Wastewater Land Application Program

Construction Permits Bureau

October 27, 1993

Crop Consumptive Use Data

Source - SCS Irrigation Guide

Seasonal Consumptive Use (Gross) in Inches
These data have been omitted. See note above

Note: Consumptive use data has been omitted from this table. Sources of more accurate values by crop type for the historic period of record (pre-1983) for a particular weather station may be obtained from the following web site: http://www.kimberly.uidaho.edu/water/appndxet/index.shtml

Climatic Area	Crop	March	April	May	June	July	Aug.	Sept.	Oct.	Gross Total	Growing Season Julian Dates Spring	Growing Season Julian Dates Fall	Growing Season Roman Dates Spring	Growing Season Roman Dates Fall
1	Alfalfa & Clovers										98	283	8-Apr	10-Oct
1	Alfalfa Grass										74	304	15-Mar	31-Oct
1	Alfalfa Seed										98	196	8-Apr	15-Jul
1	Beans										145	245	25-May	2-Sep
1	Corn, Field (Grain)										125	265	5-May	22-Sep
1	Corn, Field (Silage)										125	259	5-May	16-Sep
1	Corn, Sweet										125	227	5-May	15-Aug
1	Grain, Small Spring										82	196	23-Mar	15-Jul
1	Hops										100	243	10-Apr	31-Aug
1	Melons & Cantaloupes										121	267	1-May	24-Sep
1	Mint										98	235	8-Apr	23-Aug
1	Onions										91	258	1-Apr	15-Sep
1	Orchard (with Clover)										100	304	10-Apr	31-Oct
1	Pasture										74	304	15-Mar	31-Oct
1	Potatoes										141	253	21-May	10-Sep
1	Sugar Beets										100	283	10-Apr	10-Oct
2	Alfalfa, Seed & Clovers										115	276	25-Apr	3-Oct
2	Alfalfa Grass										98	298	8-Apr	25-Oct
2	Beans, Dry										143	244	23-May	1-Sep
2	Beans, Pole										161	232	10-Jun	20-Aug
2	Corn, Field										135	266	15-May	23-Sep
2	Corn, Sweet										135	230	15-May	18-Aug
2	Grain										91	220	1-Apr	8-Aug
2	Grass Seed & Gras Pasture										98	298	8-Apr	25-Oct
2	Peas; Dry & Lentils										110	213	20-Apr	1-Aug
2	Peas, Green										110	182	20-Apr	1-Jul
2	Potatoes										136	266	16-May	23-Sep
2	Sugar Beets										100	276	10-Apr	3-Oct
3	Alfalfa, Seed & Clovers										125	263	5-May	20-Sep
3	Alfalfa Grass										110	288	20-Apr	15-Oct

3	Beans, Dry	155	255	4-Jun	12-Sep
3	Beans, Pole	152	227	1-Jun	15-Aug
3	Corn, Field	147	237	27-May	25-Aug
3	Corn, Sweet	100	230	10-Apr	18-Aug
3	Grain	100	230	10-Apr	18-Aug
3	Grass Seed & Gras Pasture	110	288	20-Apr	15-Oct
3	Peas, Dry	121	220	1-May	8-Aug
3	Peas, Green	121	191	1-May	10-Jul
3	Potatoes	125	255	5-May	12-Sep
3	Sugar Beets	100	263	10-Apr	20-Sep
3	Truck "B"	152	263	1-Jun	20-Sep
4	Alfalfa	128	258	8-May	15-Sep
4	Alfalfa Grass	121	291	1-May	18-Oct
4	Grass Pasture & Gras Seed	121	291	1-May	18-Oct
4	Small Grain	130	232	10-May	20-Aug
4	Potatoes	152	253	1-Jun	10-Sep
5	Alfalfa	148	251	28-May	8-Sep
5	Alfalfa Grass	129	288	9-May	15-Oct
5	Clovers	148	251	28-May	8-Sep
5	Small Grain	145	244	25-May	1-Sep
5	Grass Pasture & GrassSeed	129	288	9-May	15-Oct
5	Seed Potatoes	152	227	1-Jun	15-Aug
VI	SILAGE CORN	125	259	5-May	16-Sep
VI	POTATOES	127	258	7-May	15-Sep
VI	SPRING GRAIN	105	235	15-Apr	23-Aug
VI	WINTER GRAIN	74	234	15-Mar	22-Aug
VI	FRUIT TREES (W/COVER)	121	288	1-May	15-Oct
VI	VEGETABLES	145	274	25-May	1-Oct
VII	SILAGE CORN	128	261	8-May	18-Sep
VII	SWEET CORN	140	240	20-May	28-Aug
VII	POTATOES	115	258	25-Apr	15-Sep
VII	SPRING GRAIN	100	229	10-Apr	17-Aug
VII	WINTER GRAIN	74	227	15-Mar	15-Aug
VII	FRUIT TREES (W/COVER)	110	274	20-Apr	1-Oct
VIII	SILAGE CORN	129	262	9-May	19-Sep
VIII	SWEET CORN	140	240	20-May	28-Aug
VIII	POTATOES	115	258	25-Apr	15-Sep
VIII	SPRING GRAIN	105	233	15-Apr	21-Aug
VIII	WINTER GRAIN	74	227	15-Mar	15-Aug
VIII	FRUIT TREES (W/COVER)	115	274	25-Apr	1-Oct
VIII	FRUIT TREES (NO COVER)	115	274	25-Apr	1-Oct
IX	SILAGE CORN	130	263	10-May	20-Sep
IX	PEAS	95	201	5-Apr	20-Jul
IX	SPRING GRAIN	106	239	16-Apr	27-Aug
IX	WINTER GRAIN	74	215	15-Mar	3-Aug
IX	VEGETABLES	130	233	10-May	21-Aug
X	SILAGE CORN	125	263	5-May	20-Sep
X	PEAS	100	213	10-Apr	1-Aug
X	POTATOES	115	258	25-Apr	15-Sep

X	SPRING GRAIN	98	227	8-Apr	15-Aug
X	WINTER GRAIN	74	224	15-Mar	12-Aug
XI	SILAGE CORN	100	244	10-Apr	1-Sep
XI	PEAS	91	201	1-Apr	20-Jul
XI	POTATOES	105	258	15-Apr	15-Sep
XI	WINTER GRAIN	74	202	15-Mar	21-Jul
XII	SILAGE CORN	130	265	10-May	22-Sep
XII	PEAS	105	213	15-Apr	1-Aug
XII	POTATOES	115	258	25-Apr	25-Sep
XII	SPRING GRAIN	93	227	3-Apr	15-Aug
XII	WINTER GRAIN	74	227	15-Mar	15-Aug
XIII	POTATOES	105	258	15-Apr	15-Sep
XIII	SILAGE CORN	115	253	25-Apr	10-Sep
XIII	SPRING GRAIN	84	214	25-Apr	2-Aug
XIII	WINTER GRAIN	74	206	15-Mar	25-Jul
XIII	FRUIT TREES (W/COVER)	91	288	1-Apr	15-Oct
XIII	FRUIT TREES (NO COVER)	91	288	1-Apr	15-Oct
XIII	VEGETABLES	121	227	1-May	15-Aug
XIII	PEAS	91	197	1-Apr	16-Jul
XIV	SILAGE CORN	130	273	10-May	30-Sep
XIV	SPRING GRAIN	95	225	5-Apr	13-Aug
XIV	WINTER GRAIN	74	224	15-Mar	12-Aug
XV	FIELD CORN	100	288	10-Apr	15-Oct
XV	SILAGE CORN	100	244	10-Apr	1-Sep
XV	POTATOES	105	258	15-Apr	15-Sep
XV	SPRING GRAIN	74	203	15-Mar	22-Jul
XV	WINTER GRAIN	74	202	15-Mar	21-Jul
XVI	SILAGE CORN	135	268	15-Mar	25-Sep
XVI	PEAS	105	213	15-Apr	1-Aug
XVI	POTATOES	115	258	25-Apr	15-Sep
XVI	SPRING GRAIN	105	237	15-Apr	25-Aug
XVI	FRUIT TREES (W/COVER)	120	283	30-Apr	10-Oct
XVI	FRUIT TREES (NO COVER)	120	283	30-Apr	10-Oct
XVI	VEGETABLES	143	256	23-May	13-Sep
XVII	SILAGE CORN	125	259	5-May	16-Sep
XVII	POTATOES	122	258	2-May	15-Sep
XVII	SPRING GRAIN	100	229	10-Apr	17-Aug
XVII	WINTER GRAIN	74	229	15-Mar	17-Aug
XVII	FRUIT TREES (W/COVER)	115	288	25-Apr	15-Oct
XVII	FRUIT TREES (NO COVER)	115	288	25-Apr	15-Oct
XVII	VEGETABLES	145	274	25-May	1-Oct
XVIII	SILAGE CORN	125	259	5-May	16-Sep
XVIII	PEAS	100	213	10-Apr	1-Aug
XVIII	POTATOES	110	258	20-Apr	15-Sep
XVIII	SPRING GRAIN	95	227	5-Apr	15-Aug
XVIII	WINTER GRAIN	74	227	15-Mar	15-Aug
XVIII	VEGETABLES	121	253	1-May	10-Sep

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A.2 Mean Monthly Precipitation in Idaho (1961-1990)

Note: More recent average precipitation data (1991 to 2002) may be found in AgriMet summary spreadsheet tables found in DEQ Intranet site G:\Wastewater Common-Drive\TGR Project\Project Area|Section 1.1\AgriMet summary SSs|. Also, average precipitation data from1948 to present may be found at the Desert Research Institute – Western Regional Climate Center Web site:

http://www.wrcc.dri.edu/summary/climsmid.html

Effective precipitation (PPT_e) by month for a particular weather station for the historic period of record may be derived from data provided at the following web site:

http://www.kimberly.uidaho.edu/water/appndxet/index.shtml

Specifically, $PPT_e = CU – IR_{net}$ (i.e. Mean IR). To back-calculate monthly PPT for a particular weather station for the historic period of record, divide PPT_e by 0.7.

Table A-2. Mean Monthly Precipitation - 1961 through 1990

Idaho Wastewater Land Application Program
Construction Permits Bureau

Mean Monthly Precipitation - 1961 through 1990
Source - University of Idaho

STATION	NAME	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	ANNUAL
100010	Aberdeen Exp Sta	0.73	0.68	0.73	0.83	1.23	0.97	0.51	0.60	0.74	0.78	0.85	0.78	9.43
100227	American Falls 1 Sw	1.00	0.89	1.18	1.21	1.53	1.04	0.63	0.71	0.87	0.90	1.21	1.04	12.21
100282	Anderson Dam	3.40	2.15	1.93	1.32	1.14	1.13	0.56	0.58	0.99	1.19	3.19	3.24	20.82
100347	Arbon 2 Nw	1.64	1.43	1.49	1.37	1.71	1.49	1.00	0.88	1.03	1.07	1.52	1.63	16.26
100375	Arco 3 Sw	1.00	1.01	0.84	0.80	1.28	1.27	0.78	0.91	0.80	0.55	0.96	1.07	11.27
100448	Arrowrock Dam	2.88	2.14	1.88	1.48	1.14	1.01	0.35	0.47	0.93	1.12	2.91	2.75	19.06
100470	Ashton	2.29	1.82	1.57	1.54	2.28	1.94	1.03	1.11	1.36	1.33	2.11	2.27	20.65
100528	Avery R S 2	5.37	3.61	3.22	2.54	2.79	2.34	1.30	1.57	2.06	2.63	4.21	4.53	36.17
100667	Bayview Model Basin	3.03	2.39	2.04	1.75	2.08	1.91	0.98	1.22	1.39	1.80	3.12	3.40	25.11
100915	Blackfoot 2 Ssw	0.99	0.90	0.97	1.02	1.20	1.09	0.57	0.51	0.78	0.77	1.07	0.94	10.81
101002	Bliss 4 Nw	1.39	1.04	0.94	0.76	0.87	0.81	0.26	0.38	0.55	0.66	1.54	1.37	10.57
101018	Boise Lucky Peak Dam	1.68	1.35	1.57	1.48	1.22	0.97	0.33	0.52	0.85	0.88	1.92	1.64	14.41
101022	Boise Wsfo	1.45	1.07	1.29	1.24	1.08	0.81	0.35	0.43	0.80	0.75	1.48	1.36	12.11
101079	Bonners Ferry 1 Sw	3.17	1.98	1.63	1.47	1.64	1.61	0.93	1.15	1.41	1.75	3.55	3.41	23.70
101195	Bruneau	0.82	0.60	0.73	0.70	0.63	0.84	0.19	0.34	0.57	0.51	1.02	0.78	7.73
101303	Burley Faa Ap	1.04	0.77	0.91	0.92	1.10	0.89	0.36	0.56	0.59	0.63	1.06	1.00	9.83
101363	Cabinet Gorge	4.29	3.19	2.61	2.08	2.22	2.34	1.01	1.60	1.65	2.18	4.34	4.45	31.96
101380	Caldwell	1.35	1.04	1.07	0.97	0.79	0.80	0.24	0.47	0.67	0.70	1.23	1.36	10.69
101408	Cambridge	2.98	2.33	2.12	1.22	1.17	1.13	0.32	0.57	0.90	1.26	2.77	3.07	19.84
101514	Cascade 1 Nw	2.84	2.10	2.11	1.72	1.58	1.68	0.60	0.87	1.22	1.68	2.76	3.04	22.20
101636	Centerville Arbaugh Ranch	4.24	2.96	2.53	1.88	1.67	1.60	0.71	0.74	1.43	1.64	3.53	3.86	26.79
101663	Challis	0.48	0.34	0.46	0.55	1.15	1.10	0.67	0.66	0.78	0.41	0.55	0.58	7.73
101671	Chilly Barton Flat	0.42	0.30	0.45	0.58	1.12	1.33	0.98	0.90	0.87	0.45	0.48	0.38	8.26
101932	Cobalt	1.36	0.91	0.99	1.43	1.80	1.91	1.15	1.17	1.23	0.96	1.23	1.44	15.58
101956	Coeur D' Alene R S	3.47	2.48	2.29	1.71	2.06	1.96	0.92	1.31	1.19	1.61	3.30	3.65	25.95
102159	Cottonwood 2 Wsw	2.00	1.43	1.95	2.41	2.91	2.42	1.04	1.34	1.55	1.73	2.00	1.83	22.61
102187	Council	3.92	2.76	2.46	1.75	1.79	1.57	0.56	0.75	1.24	1.70	3.43	3.70	25.63
102260	Craters Of The Moon	2.17	1.47	1.36	1.15	1.71	1.30	0.78	0.92	0.93	0.80	1.60	2.03	16.22
102444	Deer Flat Dam	1.09	0.83	1.05	0.94	0.87	0.89	0.27	0.49	0.62	0.67	1.13	1.11	9.96
102575	Dixie	3.98	2.74	2.84	2.28	2.39	2.65	1.18	1.40	1.73	1.89	2.96	3.56	29.60
102676	Driggs	1.45	1.00	1.13	1.31	2.16	1.89	1.27	1.18	1.49	1.21	1.30	1.38	16.77
102707	Dubois Exp Sta	0.72	0.66	0.83	1.02	1.68	1.81	1.11	1.07	1.07	0.75	1.16	0.90	12.78
102875	Elk City R S	3.50	2.48	2.63	2.51	3.14	2.88	1.44	1.53	1.98	2.00	2.77	3.09	29.95
102892	Elk River 1 S	5.39	4.13	3.65	2.54	2.71	2.27	1.10	1.21	1.92	2.53	4.36	5.03	36.84
102942	Emmett 2 E	1.65	1.42	1.29	1.13	1.06	0.95	0.23	0.45	0.82	0.86	1.78	1.56	13.20
103108	Fairfield R S	2.36	1.68	1.27	1.10	1.18	1.05	0.66	0.63	0.77	0.81	2.01	2.34	15.86
103143	Fenn R S	4.96	3.46	3.78	3.62	3.39	3.03	1.09	1.52	2.33	2.85	4.20	4.22	38.45
103297	Fort Hall Ind Agency	0.85	0.88	1.10	1.08	1.51	1.12	0.71	0.84	0.89	1.03	1.07	0.93	12.01
103448	Garden Valley R S	3.67	2.30	2.15	1.65	1.43	1.47	0.54	0.67	1.18	1.40	3.17	3.41	23.04
103631	Glenns Ferry	1.49	1.04	0.91	0.72	0.80	0.79	0.29	0.37	0.53	0.58	1.47	1.39	10.38
103732	Grace	1.24	1.17	1.29	1.40	1.65	1.73	1.02	1.16	1.39	1.16	1.28	1.25	15.74
103760	Grand View 2 W	0.68	0.53	0.69	0.64	0.73	0.79	0.21	0.31	0.59	0.47	0.87	0.63	7.14
103771	Grangeville	1.61	1.15	2.41	2.61	3.27	2.89	1.17	1.27	1.78	1.86	1.75	1.62	23.39
103882	Grouse	1.30	1.05	1.15	1.04	1.56	1.67	0.95	1.03	0.87	0.57	1.21	1.33	13.73
103942	Hailey Ap	2.31	1.76	1.27	1.03	1.41	1.40	0.67	0.74	0.81	0.78	1.76	2.22	16.16
103964	Hamer 4 Nw	0.60	0.46	0.67	0.80	1.36	1.17	0.83	0.76	0.67	0.59	0.78	0.65	9.34
104140	Hazelton	1.20	0.95	0.94	0.76	1.02	0.81	0.24	0.45	0.63	0.65	1.34	1.18	10.17
104150	Headquarters	5.38	3.76	3.65	3.08	3.01	2.53	1.17	1.44	2.02	2.78	4.52	4.89	38.23
104268	Hill City 1 W	2.17	1.48	1.16	0.96	1.02	1.06	0.49	0.48	0.74	0.80	1.87	2.18	14.41
104295	Hollister	0.80	0.62	0.84	0.94	1.40	1.23	0.56	0.71	0.78	0.77	1.02	0.86	10.53
104384	Howe	0.66	0.62	0.59	0.66	1.17	1.30	0.73	0.92	0.69	0.51	0.78	0.84	9.47
104442	Idaho City	3.92	2.76	2.43	1.83	1.49	1.41	0.55	0.68	1.26	1.50	3.29	3.57	24.69
104455	Idaho Falls 2 Ese	1.08	0.94	1.07	1.15	1.55	1.28	0.62	0.84	0.94	0.98	1.08	1.09	12.62

104456	Idaho Falls 16 Se	1.53	1.21	1.40	1.46	1.72	1.54	0.90	0.95	1.26	1.08	1.58	1.45	16.08
104457	Idaho Falls Faa Ap	0.81	0.76	0.82	1.01	1.38	1.24	0.62	0.70	0.86	0.82	0.99	0.87	10.88
104460	Idaho Falls 46 W	0.71	0.60	0.61	0.80	1.16	1.25	0.62	0.54	0.79	0.55	0.77	0.76	9.16
104598	Island Park	3.93	3.05	2.75	2.18	2.29	2.64	1.58	1.68	1.82	1.68	2.75	3.50	29.85
104670	Jerome	1.25	1.08	1.14	0.86	0.91	0.84	0.25	0.42	0.58	0.69	1.36	1.32	10.70
104793	Kamiah	2.32	1.69	2.46	2.37	2.74	2.16	0.94	1.21	1.61	1.90	2.28	2.14	23.82
104831	Kellogg	4.20	2.93	2.78	2.31	2.46	2.17	1.08	1.43	1.76	2.02	3.75	4.08	30.97
105038	Kuna 2 Nne	1.14	0.79	0.92	1.03	1.04	0.79	0.27	0.46	0.63	0.66	1.28	1.09	10.10
105241	Lewiston Wso Ap	1.28	0.89	1.09	1.13	1.31	1.25	0.67	0.78	0.78	0.90	1.15	1.20	12.43
105275	LIFTON PUMPING STN	0.67	0.69	0.74	1.00	1.28	1.14	0.80	0.84	1.21	0.98	0.84	0.66	10.85
105414	Lowman	3.98	2.86	2.44	1.87	1.59	1.61	0.59	0.82	1.26	1.60	3.36	3.72	25.70
105462	Mackay R S	0.80	0.47	0.67	0.66	1.20	1.27	1.08	0.92	0.84	0.44	0.71	0.82	9.88
105559	Malad City	1.18	1.03	1.14	1.22	1.73	1.47	1.15	0.93	1.14	1.12	1.22	1.15	14.48
105563	Malta 2 E	0.77	0.61	0.80	0.99	1.55	1.29	0.87	0.94	0.82	0.73	0.87	0.75	10.99
105685	May	0.43	0.28	0.28	0.57	1.28	1.38	0.85	0.81	0.79	0.42	0.61	0.54	8.24
105708	Mccall	3.79	2.79	2.63	1.97	2.08	2.07	0.81	1.15	1.72	1.91	3.18	3.54	27.64
105980	Minidoka Dam	0.94	0.77	0.94	0.93	1.16	0.91	0.35	0.49	0.63	0.69	1.12	0.96	9.89
106053	Montpelier R S	1.27	1.18	1.24	1.25	1.50	1.48	0.87	0.96	1.32	1.14	1.28	1.25	14.74
106152	Moscow Univ Of Idaho	3.11	2.27	2.40	2.16	2.24	1.78	0.94	1.16	1.28	1.85	3.28	3.01	25.48
106174	Mountain Home Afb	1.34	0.92	1.05	0.95	0.73	0.88	0.40	0.42	0.67	0.67	1.43	1.45	10.91
106388	New Meadows R S	3.34	2.47	2.41	1.87	1.88	1.84	0.70	0.82	1.44	1.76	2.85	3.41	24.79
106424	Nez Perce	1.73	1.32	1.93	2.19	2.80	2.13	1.10	1.33	1.49	1.68	1.89	1.72	21.31
106542	Oakley	0.79	0.61	0.98	1.01	1.67	1.41	0.79	0.99	0.84	0.75	0.88	0.80	11.52
106590	Ola 4 S	2.57	2.02	2.09	1.67	1.26	1.24	0.49	0.65	0.91	1.35	2.71	2.70	19.66
106681	Orofino	3.00	2.32	2.52	2.23	2.37	1.87	0.98	1.04	1.44	1.87	2.81	3.27	25.72
106764	Palisades	2.02	1.61	1.48	1.62	2.36	2.00	1.24	1.40	1.70	1.36	1.79	1.70	20.28
106844	Parma Exp Sta	1.48	0.99	1.16	0.94	0.95	0.99	0.29	0.58	0.71	0.76	1.32	1.41	11.58
106877	Paul 1 Ene	0.94	0.72	0.84	0.82	1.15	0.92	0.40	0.48	0.64	0.69	1.04	0.95	9.59
106891	Payette	1.45	1.13	1.04	0.81	0.75	0.78	0.23	0.48	0.53	0.70	1.53	1.64	11.07
107040	Picabo	1.77	1.34	1.18	0.91	1.22	1.14	0.42	0.54	0.75	0.74	1.64	1.82	13.47
107046	Pierce	5.39	4.24	4.11	3.42	3.49	2.83	1.25	1.55	2.23	3.02	4.71	5.26	41.50
107211	Pocatello Wso Ap	1.04	0.92	1.26	1.20	1.35	1.02	0.65	0.67	0.85	0.91	1.16	1.11	12.14
107264	Porthill	2.23	1.58	1.49	1.38	1.72	1.81	1.07	1.27	1.41	1.38	2.77	2.52	20.63
107301	Potlatch 3 Nne	3.08	2.50	2.42	2.05	2.16	1.82	0.91	1.12	1.32	1.62	3.03	3.28	25.31
107320	Powell	5.80	3.74	3.12	2.44	2.77	2.83	1.24	1.75	2.34	2.85	4.37	5.01	38.26
107386	PRIEST RIVER EXP STN	3.96	3.12	2.77	2.08	2.44	2.06	1.21	1.45	1.53	2.02	4.33	4.46	31.43
107648	Reynolds	1.13	0.86	0.95	1.01	1.05	1.24	0.33	0.66	0.58	0.81	1.16	1.14	10.92
107673	Richfield	1.64	1.23	1.10	0.74	1.01	0.78	0.37	0.49	0.55	0.64	1.56	1.64	11.75
107706	Riggins	1.50	1.11	1.86	1.70	2.07	1.90	0.90	0.91	1.13	1.34	1.58	1.45	17.45
108022	St Anthony 1 Wnw	1.23	0.92	0.98	1.16	1.66	1.56	0.89	0.80	1.08	0.92	1.40	1.38	13.98
108062	Saint Maries	4.15	2.96	2.77	2.18	2.24	1.99	1.00	1.34	1.42	1.84	3.59	3.88	29.36
108080	Salmon Ksra	0.70	0.50	0.51	0.79	1.40	1.48	0.89	0.92	0.82	0.56	0.75	0.77	10.09
108137	Sandpoint Exp Sta	4.06	3.31	2.85	2.12	2.52	2.26	1.26	1.63	1.71	2.35	4.74	4.69	33.50
108380	Shoshone 1 Wnw	1.26	1.06	1.13	0.70	0.77	0.70	0.25	0.40	0.56	0.62	1.41	1.29	10.15
108676	Stanley	2.05	1.57	1.29	1.14	1.32	1.46	0.74	0.87	1.01	1.03	1.65	2.23	16.36
108928	Swan Falls Power House	0.82	0.53	0.81	0.99	0.96	0.81	0.26	0.35	0.57	0.51	0.93	0.72	8.26
108937	Swan Valley 2 E	1.47	1.06	1.04	1.48	2.32	1.65	1.25	1.29	1.61	1.15	1.48	1.22	17.02
109065	TETONIA EXP STN	1.54	1.21	1.03	1.20	2.28	1.81	1.36	1.31	1.54	1.31	1.36	1.42	17.37
109303	Twin Falls Wso	1.09	0.89	1.06	0.92	1.08	0.86	0.29	0.46	0.70	0.73	1.22	1.10	10.40
109498	Wallace Woodland Park	5.51	4.05	3.72	2.80	2.82	2.58	1.29	1.51	1.98	2.75	4.99	5.24	39.24
109560	Warren	3.21	2.07	2.77	2.14	2.41	2.63	1.17	1.38	1.73	2.09	2.65	2.85	27.10
109638	Weiser 2 Se	1.46	1.14	1.07	0.91	0.77	0.88	0.22	0.46	0.56	0.74	1.66	1.62	11.49

A.3 Table to Calculate Effective Precipitation

From: USDA National Resource Conservation Service. National Engineering Handbook - Irrigation Water Requirements, Title 210, Chapter VI, Part 653.0207e. September 1997.

Table A-3. Average monthly effective precipitation (PPTe) as related to mean monthly precipitation and average monthly crop consumptive use[1]

Monthly Mean Precipitation PPT ŧt Inches	Average Monthly Crop Consumptive Use, CU, in Inches										
	0.00	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.00
	Average Monthly Effective Precipitation, PPTe in Inches										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.5	0.28	0.30	0.32	0.34	0.36	0.38	0.40	0.42	0.45	0.47	0.50
1.0	0.59	0.63	0.66	0.70	0.74	0.78	0.83	0.88	0.93	0.98	1.00
1.5	0.87	0.93	0.98	1.03	1.09	1.16	1.22	1.29	1.37	1.45	1.50
2.0	1.14	1.21	1.27	1.35	1.43	1.51	1.59	1.69	1.78	1.88	1.99
2.5	1.39	1.47	1.56	1.65	1.74	1.84	1.95	2.06	2.18	2.30	2.44
3.0		1.73	1.83	1.94	2.05	2.17	2.29	2.42	2.56	2.71	2.86
3.5		1.98	2.10	2.22	2.35	2.48	2.62	2.77	2.93	3.10	3.28
4.0		2.23	2.36	2.49	2.63	2.79	2.95	3.12	3.29	3.48	3.68
4.5			2.61	2.76	2.92	3.09	3.26	3.45	3.65	3.86	4.08
5.0			2.86	3.02	3.20	3.38	3.57	3.78	4.00	4.23	4.47
5.5			3.10	3.28	3.47	3.67	3.88	4.10	4.34	4.59	4.85

6.0	3.53	3.74	3.95	4.18	4.42	4.67	4.94	5.23
6.5	3.79	4.00	4.23	4.48	4.73	5.00	5.29	5.60
7.0	4.03	4.26	4.51	4.77	5.04	5.33	5.64	5.96
7.5		4.52	4.78	5.06	5.35	5.65	5.98	6.32
8.0		4.78	5.05	5.34	5.65	5.97	6.32	6.68

1/ The PPTe values in the table are based on 3-inches of useable soil water storage (D). D is estimated to be from 40 to 60 percent of the available water holding capacity in the crop root zone, depending on irrigation management practices used. For other values of useable soil water storage, multiply table entries by the soil water storage factors (SF) shown below which correspond to the useable soil water storage (D).

Useable Soil Water storage	(D)	.75	1.0	1.5	2.0	2.5	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.00
Soil Water StorageFactor	(SF)	.722	.773	.86	.93	.97	1.00	1.02	1.04	1.06	1.07	1.148	1.288	1.518

Note: Average monthly effective precipitation cannot exceed average monthly precipitation or average monthly crop consumptive use. When the application of the above factors results in a value of effective rainfall exceeding either, this value must be reduced to a value equal the lesser of the two.

Effective Precipitation may also be calculated from the following equations:

$$PPTe = SF[(0.70917\ PPT^{(0.82416)} - 0.11556)\ (10)^{(0.02426\ CU)}]$$

where $SF = (0.531747 + 0.295164D - 0.057697D^2 + 0.003804D^3)$

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A.4 Mean Monthly Temperatures in Idaho

Editor's Note: These data are no longer necessary since the guidance is no longer prescribing a computational approach for determining ET. However, these data might be generally useful for site characterizations. They are retained in this edit of the guidance.

Table A-4. Mean Monthly Temperatures in Idaho

Idaho Wastewater Land Application Program

Mean Monthly Temperature - 1961 through 1990
Source - University of Idaho

Station	Name	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
100010	Aberdeen Exp Sta	20.25	26.25	34.25	43.35	52.15	60.65	67.65	65.65	55.80	45.05	33.30	22.65	43.90
100227	American Falls 1 Sw	23.45	29.30	36.65	45.30	54.10	63.10	70.70	68.90	59.45	48.20	35.90	25.90	46.75
100282	Anderson Dam	26.40	30.05	36.70	46.15	55.50	64.40	72.75	71.55	61.55	51.05	37.50	27.70	48.40
100347	Arbon 2 Nw	21.85	26.75	34.05	43.15	51.65	60.20	68.05	66.60	57.25	46.55	33.65	23.50	44.45
100375	Arco 3 Sw	15.85	21.70	31.25	42.40	51.85	60.00	66.85	64.95	55.60	45.20	30.25	17.95	41.95
100448	Arrowrock Dam	26.50	31.85	38.85	46.80	55.35	64.30	72.50	71.30	60.80	49.80	37.50	28.35	48.65
100470	Ashton	17.25	22.65	29.10	39.90	49.95	57.70	64.25	62.50	53.70	43.30	30.30	18.90	40.80
100528	Avery R S 2	27.05	30.75	37.10	45.05	53.45	61.10	66.90	66.50	57.70	46.60	35.40	27.55	46.25
100667	Bayview Model Basin	27.40	30.90	35.70	42.50	50.40	58.00	63.30	62.50	53.40	43.40	35.35	28.85	44.30
100915	Blackfoot 2 Ssw	22.20	28.30	36.30	45.65	54.15	62.30	69.25	67.35	58.00	47.45	35.10	24.15	45.85
101002	Bliss 4 Nw	27.95	34.35	41.30	49.05	57.20	66.10	72.95	71.15	61.75	51.35	39.15	29.40	50.15
101018	Boise Lucky Peak Dam	29.85	35.85	42.15	49.50	57.80	66.55	74.40	73.55	63.75	53.20	40.65	30.95	51.55
101022	Boise Wsfo	29.00	35.85	42.40	49.05	57.45	66.50	73.95	72.45	62.60	51.80	39.90	30.10	50.95
101079	Bonners Ferry 1 Sw	26.50	32.05	38.40	46.55	54.50	61.65	66.60	66.10	56.60	45.50	34.90	27.65	46.40
101195	Bruneau	30.80	37.30	44.00	51.20	59.85	68.45	75.40	73.30	63.20	52.50	40.65	31.10	52.30
101303	Burley Faa Ap	26.25	32.30	38.60	46.35	54.45	63.05	70.05	68.10	58.75	48.50	37.00	27.75	47.60
101363	Cabinet Gorge	26.65	31.60	37.35	45.30	53.35	60.45	66.15	65.80	57.00	46.60	35.30	28.05	46.10
101380	Caldwell	29.15	36.45	44.40	51.85	60.35	68.85	75.60	73.75	63.10	51.75	40.20	30.50	52.15
101408	Cambridge	22.30	28.45	38.90	48.00	56.15	64.60	71.85	69.90	59.80	48.25	36.10	24.85	47.40
101514	Cascade 1 Nw	19.15	23.70	29.95	38.35	47.35	55.70	62.70	61.15	51.90	41.75	30.05	20.90	40.20
101663	Challis	19.90	26.45	34.60	43.55	52.35	60.95	68.45	66.20	56.55	45.70	31.95	20.65	43.95
101671	Chilly Barton Flat	16.40	21.35	28.75	38.70	47.40	55.95	62.95	61.00	51.90	42.05	28.20	17.25	39.35
101932	Cobalt	18.75	25.10	32.00	40.55	48.75	56.70	63.35	61.55	53.10	42.85	29.80	19.00	40.95
101956	Coeur D' Alene R S	29.80	34.70	39.75	47.20	55.25	62.80	69.25	69.55	60.40	49.95	38.65	31.30	49.05
102187	Council	24.70	30.30	39.30	48.35	56.45	65.15	73.25	72.00	61.70	49.80	37.45	27.10	48.80
102260	Craters Of The Moon	19.00	23.45	30.20	40.65	50.30	59.20	67.70	66.15	55.60	44.90	30.50	20.20	42.30
102444	Deer Flat Dam	28.85	36.05	43.80	51.15	59.00	66.65	72.70	71.25	62.25	51.60	40.20	30.20	51.15
102575	Dixie	16.90	20.85	25.85	33.40	42.10	50.35	56.35	55.40	46.95	37.80	26.05	17.55	35.80
102676	Driggs	18.05	22.55	29.20	38.95	48.15	56.55	63.95	62.15	53.20	42.95	29.95	19.55	40.45
102707	Dubois Exp Sta	18.45	23.30	30.40	41.50	51.35	59.95	68.55	66.90	56.95	45.45	30.75	20.10	42.80
102875	Elk City R S	22.05	27.45	31.95	39.40	47.15	55.20	60.60	59.80	51.70	42.70	31.80	22.40	41.05
102892	Elk River 1 S	25.25	29.95	34.95	42.40	49.90	57.50	63.00	62.70	53.95	44.05	34.05	26.10	43.65
102942	Emmett 2 E	28.00	35.00	42.35	49.40	57.70	66.30	72.80	70.85	61.60	50.65	38.75	29.85	50.30
103108	Fairfield R S	17.50	21.85	29.75	41.10	50.50	58.10	65.75	63.95	54.70	44.85	31.30	19.30	41.55
103143	Fenn R S	29.15	34.50	40.65	47.95	55.35	62.80	69.65	68.90	59.25	47.90	37.95	30.35	48.70
103297	Fort Hall Ind Agency	21.70	28.20	35.65	44.50	53.40	62.20	69.25	67.20	57.85	46.85	34.50	23.70	45.40
103448	Garden Valley R S	25.80	30.95	38.05	45.75	54.45	62.60	69.15	67.90	58.80	48.10	35.60	26.30	46.95
103631	Glenns Ferry	29.70	36.00	42.75	50.45	58.85	67.90	75.35	72.65	62.50	51.10	39.45	30.50	51.45
103732	Grace	20.30	24.40	31.75	41.95	50.85	58.80	65.85	64.30	55.60	45.40	32.55	22.20	42.85
103760	Grand View 2 W	29.85	36.75	43.90	51.50	59.95	68.35	74.65	72.40	62.20	51.35	39.90	30.10	51.75
103771	Grangeville	29.20	33.95	38.15	44.15	51.20	59.00	65.70	65.50	56.30	46.85	36.50	29.85	46.40
103882	Grouse	13.35	17.85	26.05	36.70	46.25	53.70	60.00	58.70	49.95	39.90	26.35	14.70	36.95
103942	Hailey Ap	19.60	24.45	31.70	41.75	50.35	58.85	66.45	65.30	56.25	46.15	32.45	21.05	42.85
103964	Hamer 4 Nw	15.20	21.85	31.70	42.85	52.65	61.00	67.75	65.25	55.50	44.05	29.95	17.60	42.15
104140	Hazelton	25.65	31.55	38.35	46.30	54.85	63.60	71.10	69.00	59.30	48.95	36.80	27.35	47.75

104150	Headquarters	25.55	29.55	34.30	41.30	48.90	57.20	62.80	62.40	53.30	43.90	33.40	25.95	43.20
104268	Hill City 1 W	18.05	21.85	29.45	40.80	50.15	57.60	65.30	64.20	54.85	44.60	31.30	19.65	41.50
104295	Hollister	27.85	33.10	38.50	45.75	53.65	62.50	70.40	68.95	59.35	49.00	37.60	28.90	47.95
104384	Howe	18.20	24.70	34.60	45.60	54.10	62.00	68.95	66.75	56.75	45.85	31.90	19.65	44.10
104442	Idaho City	23.55	28.10	34.30	42.20	50.80	58.70	65.80	64.50	55.60	45.70	33.35	24.40	43.95
104455	Idaho Falls 2 Ese	18.90	25.40	33.60	43.40	52.90	61.45	68.90	66.65	56.95	45.60	33.10	21.40	44.00
104456	Idaho Falls 16 Se	20.05	24.30	30.25	39.05	47.95	56.05	63.30	61.50	52.50	42.75	30.75	21.25	40.80
104457	Idaho Falls Faa Ap	18.15	24.10	33.65	43.55	52.50	61.25	68.60	66.60	56.65	45.30	32.55	20.45	43.60
104460	Idaho Falls 46 W	15.35	21.35	31.00	41.80	51.25	60.20	68.20	66.15	55.65	43.70	30.10	17.45	41.85
104598	Island Park	14.60	18.75	24.40	34.60	45.00	53.90	61.05	59.75	50.55	40.40	27.00	15.45	37.10
104670	Jerome	26.10	31.80	38.90	47.05	56.05	65.05	73.00	71.10	61.10	50.10	37.65	27.80	48.80
104831	Kellogg	27.35	32.85	38.45	45.95	53.85	61.55	67.35	66.70	57.95	46.80	35.90	28.35	46.90
105038	Kuna 2 Nne	28.30	35.35	42.40	49.10	56.70	64.85	70.60	69.10	60.20	50.35	39.15	29.45	49.65
105241	Lewiston Wso Ap	33.60	39.05	44.10	50.60	58.35	66.85	74.10	73.60	64.05	52.30	41.25	34.45	52.70
105275	LIFTON PUMPING STN	16.95	19.15	26.95	39.30	50.40	59.20	66.60	63.60	53.80	42.65	30.75	20.20	40.80
105414	Lowman	24.15	29.65	35.90	43.85	51.85	59.20	65.60	64.55	55.65	46.00	33.40	23.80	44.50
105462	Mackay R S	17.50	22.70	30.25	40.95	50.15	58.70	66.05	64.15	54.75	44.55	30.45	18.40	41.55
105559	Malad City	21.65	27.20	36.30	45.45	53.85	62.30	69.95	68.40	58.65	47.70	35.10	23.60	45.85
105563	Malta 2 E	26.10	31.95	38.10	45.85	53.60	61.75	69.40	67.95	58.25	48.00	36.30	27.25	47.05
105685	May	19.90	26.65	34.90	43.25	51.45	59.70	66.60	64.85	55.75	45.30	31.95	20.45	43.40
105708	Mccall	21.65	25.65	30.75	38.80	47.45	55.60	62.20	61.05	52.05	42.85	31.80	23.35	41.10
105980	Minidoka Dam	23.15	28.85	36.40	44.85	54.10	63.20	70.95	69.10	59.60	48.30	36.00	25.75	46.65
106053	Montpelier R S	20.25	22.70	30.55	41.10	50.15	58.70	66.75	65.10	55.35	45.25	31.90	21.65	42.45
106152	Moscow Univ Of Idaho	28.55	33.95	39.20	45.70	52.80	59.55	65.55	66.15	58.35	48.35	36.90	29.30	47.00
106174	Mountain Home Afb	28.00	34.05	40.55	48.05	56.70	66.15	74.00	72.30	61.75	50.55	38.25	29.40	50.00
106388	New Meadows R S	18.90	24.10	31.65	40.55	48.65	56.85	63.15	62.05	52.50	42.40	31.65	20.65	41.10
106424	Nez Perce	27.70	33.00	37.60	43.95	51.00	58.35	64.50	64.80	56.15	46.50	35.65	28.45	45.65
106542	Oakley	28.50	33.80	39.05	46.00	53.80	62.30	69.80	68.75	59.65	50.00	38.30	29.60	48.30
106590	Ola 4 S	25.20	32.15	40.00	47.30	55.50	63.65	70.55	69.10	59.50	48.30	36.45	26.95	47.90
106681	Orofino	30.45	36.60	42.95	50.30	58.10	65.40	71.65	71.40	61.95	49.80	38.90	31.80	50.80
106764	Palisades	21.15	25.30	31.90	41.95	51.45	60.00	68.00	66.20	57.45	47.25	34.45	23.80	44.10
106844	Parma Exp Sta	26.35	33.75	42.00	49.45	57.85	65.80	72.45	70.70	60.55	49.35	38.20	28.45	49.60
106877	Paul 1 Ene	25.40	30.85	37.45	45.35	53.80	62.65	70.05	68.15	58.30	47.95	36.60	27.30	47.00
106891	Payette	27.80	35.55	44.40	51.90	59.90	68.05	74.60	73.00	63.30	51.70	39.90	29.55	51.65
107040	Picabo	18.05	22.75	31.10	41.50	50.40	59.00	66.70	65.15	55.20	44.75	31.45	20.35	42.20
107046	Pierce	23.80	27.85	32.90	40.20	48.60	56.30	62.20	61.30	52.20	42.30	32.00	24.65	42.00
107211	Pocatello Wso Ap	23.30	29.10	36.30	44.90	53.55	62.65	70.55	68.60	58.95	48.00	35.60	24.75	46.35
107264	Porthill	24.05	29.40	36.45	45.55	53.85	60.90	65.95	64.85	55.35	43.90	33.45	26.10	45.00
107301	Potlatch 3 Nne	28.20	33.70	38.15	44.35	51.15	57.75	62.80	62.60	54.70	45.60	36.05	29.10	45.35
107320	Powell	23.45	28.15	33.30	40.70	48.75	57.45	63.75	62.90	53.55	43.55	31.75	23.75	42.55
107386	PRIEST RIVER EXP STN	24.60	29.55	35.45	43.45	52.20	59.35	64.50	64.00	55.15	44.15	32.85	25.95	44.30
107648	Reynolds	28.30	33.45	38.35	44.85	53.05	61.40	68.95	67.85	57.80	47.85	37.15	29.00	47.30
107673	Richfield	20.90	26.30	34.75	43.90	52.60	61.20	68.95	67.15	57.95	46.90	34.05	23.10	44.80
107706	Riggins	34.25	40.20	45.55	52.50	59.95	67.60	75.40	75.10	65.25	54.25	42.50	35.10	53.95
108022	St Anthony 1 Wnw	17.45	22.35	30.30	41.05	50.55	58.30	64.90	63.15	54.30	44.25	31.30	19.50	41.45
108062	Saint Maries	28.40	34.00	39.55	46.40	53.95	61.40	67.45	67.05	58.30	47.20	36.30	29.10	47.45
108080	Salmon Ksra	20.70	28.30	37.40	46.05	54.20	62.40	69.45	67.30	57.35	45.90	33.30	22.10	45.35
108137	Sandpoint Exp Sta	24.75	30.30	36.70	44.70	52.60	59.55	64.55	63.75	55.30	44.40	33.80	26.75	44.75
108380	Shoshone 1 Wnw	24.15	30.10	38.00	47.30	56.75	66.15	74.45	72.60	61.50	49.65	36.15	25.90	48.60
108676	Stanley	12.80	17.65	24.45	33.75	43.25	51.15	57.05	55.55	47.40	38.65	25.55	13.05	35.00
108928	Swan Falls Pwr House	32.35	39.25	46.65	54.30	62.95	71.80	79.70	77.75	67.25	55.85	42.95	33.10	55.35
108937	Swan Valley 2 E	19.40	23.75	31.35	40.60	49.60	57.40	64.60	62.80	54.05	43.70	31.80	21.45	41.70
109065	TETONIA EXP STN	14.25	19.85	25.90	36.05	46.40	54.80	62.10	60.20	50.85	39.95	26.80	15.95	37.75
109303	Twin Falls Wso	26.90	32.75	38.70	45.75	53.85	62.15	68.80	67.00	57.70	48.10	37.15	28.20	47.25
109498	Wallace Woodland Park	25.85	30.70	35.65	43.05	50.65	58.00	64.15	64.05	55.20	45.55	34.60	26.85	44.55
109560	Warren	20.00	23.95	27.60	34.80	43.30	50.90	56.75	55.30	48.10	40.00	28.50	20.30	37.45
109638	Weiser 2 Se	25.30	32.65	41.75	49.10	57.65	65.80	72.35	69.95	60.45	49.00	37.35	27.75	49.10

A.5 Hydraulic Data for Hydrogeological Settings in Idaho

Table A-5. Hydrologic Data and References for the Basic I Calculations, Idaho Wellhead Protection Program

Hydrogeologic Setting	Transmissivity (T)	Aquifer Thickness (b)	Hydraulic Conductivity (K)	Hydraulic Gradient (I)	Effective Porosity (Ne)	Values Used for Basic I Calculations
East Snake River Plain Basalts	650,000 - 67,240,000 gpd/ft Ref: (12,21,25, 26) 400,000 gpd/ft (Avg) Ref: (18)	Several 100 to 1,000 ft Ref: (21) 500 - 4,000 ft Ref: (20)	3,740 -37,400 gpd/ft' Min = 74.8 gpd/ft^2 Max = 74,800 gpd/ft^2 Ref: (2, 23)	.001 - .006 Ref: (23) Gradient as low as .0003 exist. Ret: (26)	.11 - .19 Ref: (3, 17)	T = 400,000 gpd/ft b = 600 ft. I = 0.004 Ne 0.15
Columbia River Basalts	20,196 - 2,01 9,600 gpd/ft Ref: (1) 40,000 gpd/ft (Avg) Ref: (18)	20 - 800 ft. Ref: (1, 8)		.0002 Ref: (24)	.004 - .19 Ref: (4) 0.0002 Ref: (13)	T= 40,000 gpd/ft b = 400 ft I = 0.0002 Ne=0.1
Rathdrum Prairie	2,019,600 - 97,240,000 gpd/ft Ref: (10,16)	500 -1,000 ft Ref: (10, 6) 250 - 400 ft Ref: (27)	3,740 - 164,560 gpd/ft^2 Ref: (10, 16)	.0004 - .005 Ref: (10, 16) .0005 - .009 Ref: (27)	.25 - .30 Ref: (10)	See Rathdrum Prairies Aquifer delineation in Chapter 3.
Unconsolidated Alluvium	200,000 gpd/ft. (Avg) Ref: (18)	100 ft. estimated	74.8 - 2,992 gpd/ft^2 Ref: (10, 16)	.003 - .02 Ref: (5, 6, 7)	.20 - .35 Ref: (11)	T= 200,000 gpd/ft b= 100 ft. 1= 0.01 Ne = 0.3
Mixed Volcanic and Sedimentary Rocks - Primarily Sedimentary Rocks (Example: Boise/ Nampa area)	6,732 - 160,820 gpd/ft Ref: (29) 30,000 gpd/ft (Avg) Ref (18)	500 - 4,000 ft Ref: (29) 500 - 1,000 ft Ref: (33)	74.8 -748 gpd/ft^2 upper 500 ft Ref: (29)	.002 - .004 Ref: (22)	.10 - .30 Ref: (11)	T = 30,000 gpd/ft b = 800 ft I = 0.003 Ne = 0.2
Mixed Volcanic and Sedimentary Rocks - Primarily Volcanic Rocks (Example: Mtn Home)	374,000 gpd/ft Ref: (35)	500 -600 ft Ref: (30)		.012 - .015 Ref: (22)	.11 - .19 Ref: (11)	T = 400,000 gpd/ft b = 600 ft I = 0.01 Ne = 0.2

A.6 Well Test Data/ Transmissivity Values for Wells in Idaho

Table A-6. Idaho Department of Water Resources Energy Data

Aquifer	City	Pumpid	Testdat	SWL	PWL	PWL-SWL	Flow	SC	Est R(')	Est R(")	T(art.)
Alluv	Challis	West Well #2	19880802	317.0	487.5	170.5	522	3.1	0.83	10	4690
Alluv	Rockland	25-hp Vertical Turbin	19890906	111.0	177.0	66.0	245	3.7	0.67	8	5970
Alluv	New Meadows	Submersible	19890901	19.0	78.0	59.0	253	4.3	0.67	8	6980
Alluv	Rockland	25-hp Submersible	19890906	111.0	177.0	66.0	322	4.9	0.67	8	8020
Alluv	Arimo	#1	19890717	30.0	56.0	26.0	346	13.3	0.67	8	23500
Alluv	Ketchum	Well #2	19880929	18.0	39.3	21.3	347	16.3	0.67	8	29100
Alluv	Bancroft	City Pump	19890719	95.0	104.0	9.0	188	20.9	0.67	8	38000
Alluv	Mackay	30-hp Submersible	19890913	11.0	27.0	16.0	420	26.2	0.83	10	47100
Alluv	Mackay	Well Pump #2	19910819	11.7	22.7	11.0	290	26.4	0.67	8	48700
Alluv	Tetonia	Park Well	19891107	101.0	110.0	9.0	395	43.9	0.83	10	81600
Alluv	Riggins	Well #2-new Pump	19900612	50.0	57.0	7.0	388	55.4	0.83	10	104000
Alluv	Grace	Well Pump	19890719	161.0	172.0	11.0	660	60.0	1.00	12	111000
Alluv	Bancroft	Railroad Pump	19890719	106.0	108.0	2.0	115	57.4	0.50	6	115000
Alluv	Ketchum	Well #1	19880929	59.3	75.6	16.3	1054	64.7	1.10	13.25	118000
Alluv	Malad	Five Points Well	19890718	78.0	82.0	4.0	263	65.7	0.67	8	129000
Alluv	Dayton	Park Well	19890718	52.0	56.0	4.0	333	83.3	0.83	10	161000
Alluv	Arco	Park Pump	19891016	125.0	135.0	10.0	906	90.6	0.00	12	172000
Alluv	Sun Valley	Pump #8	19880927	19.0	29.9	10.9	1139	104.5	1.10	13.25	198000
Alluv	Pocatello	Well #32	19880608	59.2	71.5	12.3	1604	130.4	1.10	13.25	251000
Alluv	Pocatello	Well #29	19880607	70.8	87.9	17.1	2493	145.8	1.27	15.25	277000
Alluv	Pocatello	Well #2	19880607	34.9	43.5	8.6	1265	147.0	1.10	13.25	285000
Alluv	Sun Valley	Pump #5	19880927	12.5	16.0	3.5	787	224.9	1.00	12	452000
Alluv	Pocatello	Well #27	19880607	63.3	69.2	5.9	1623	275.2	1.10	13.25	554000
Alluv	Sun Valley	Pump #7	19880927	20.0	23.5	3.5	1039	296.9	1.10	13.25	601000
Alluv	Pocatello	Well #18	19880608	66.2	72.6	6.4	2020	315.5	1.27	15.25	630000
Alluv	Pocatello	Pip Well	19880608	69.6	72.6	3.0	1188	395.8	1.10	13.25	815000
Alluv	Malad	Spring Creek Well/5	19890718	84.0	85.0	1.0	413	413.2	0.83	10	881000
Alluv	Pocatello	Well #16	19880607	46.7	49.5	2.8	2267	809.8	1.27	15.25	1710000
Alluv	Pocatello	Well #28	19880607	34.6	35.9	1.3	1755	1349.8	1.27	15.25	2930000
Alluv	Pocatello	Well #31	19880608	62.2	64.1	1.9	2937	1546.0	1.27	15.25	3380000
Alluv	Pocatello	Well #12	19880607	43.3	44.7	1.4	2812	2008.2	1.27	15.25	4460000
Alluv	Pocatello	Well #10	19880607	52.4	53.9	1.5	3419	2279.5	1.60	19.25	4970000
Alluv	Pocatello	Well #21	19880607	79.6	80.1	0.5	1581	3161.8	1.10	13.25	7300000
Alluv	Pocatello	Cree Well	19880606	35.4	35.5	0.1	388	3877.0	0.83	10	9320000
Alluv	Pocatello	Well #22	19880607	87.5	87.6	0.1	871	8714.0	1.10	13.25	2E+07
CR Basalt	Kooskia	Well #3	19881004	101.0	350.0	249.0	246	1.0	0.67	8	1420
CR Basalt	Council	Pump #1	19870619	277.2	374.2	97.0	337	3.5	0.83	10	5380
CR Basalt	Moscow	Cemetary Well	19880822	170.4	228.2	57.8	467	8.1	0.83	10	13300
CR Basalt	Moscow	Cemetary Well	19880822	170.4	228.2	57.8	708	12.3	1.00	12	20300
CR Basalt	Council	Pump #2	19870619	50.0	79.2	29.2	356	12.2	0.83	10	20700
CR Basalt	Kooskia	Well #1	19881004	43.5	64.0	20.5	248	12.1	0.67	8	21200
CR Basalt	Kooskia	Well #2	19881004	45.5	66.0	20.5	255	12.4	0.67	8	21800
CR Basalt	Univ of Idaho	Well #4	19880824	195.0	295.4	100.4	1901	18.9	1.27	15.25	31300
CR Basalt	Moscow	Well #8	19880822	370.2	404.9	34.7	980	28.2	1.10	13.25	49000
CR Basalt	Moscow	Well #6	19880823	344.9	376.1	31.2	1339	42.9	1.10	13.25	76700
CR Basalt	Moscow	Well #2	19880822	138.7	153.8	15.1	864	57.2	1.10	13.25	104000
CR Basalt	Univ of Idaho	Well #3	19880824	297.0	301.0	4.0	1812	453.1	1.27	15.25	924000
CR Basalt	Lewiston	Well #5	19880713	150.6	152.0	1.4	1180	842.6	1.10	13.25	1810000
E. Snake	Hollister	Well Pump	19890816	158.0	189.0	31.0	197	6.4	0.50	6	11100
E. Snake	Roberts	Well #2	19880626	23.9	47.1	23.2	407	17.6	0.83	10	30600
E. Snake	Filer	Pump #5	19870603	42.4	60.4	18.0	345	19.2	0.83	10	33700
E. Snake	Teton	Well #2	19891019	91.5	100.0	8.5	252	29.6	0.67	8	55300

Header Explanation for Table F- 1

Aquifer = Aquifer Name
- Alluv = Unconsolidated Alluvium
- CR Basalt = Columbia River Basalts
- E. Snake = Eastern Snake River Plain Basalts
- MVS-VS = Mixed Volcanic and Sedimentary Rocks, Primarily Volcanic Rocks
- MVS-Sed = Mixed Volcanic and Sedimentary Rocks, Primarily Sedimentary Rocks
- Rathdrum = Rathdrum Prairie Aquifer

City = City location of the well
Pumpid = Well identification
SWL = Static water level, in feet
PWL = Pumping water level, in feet
PWL-SWL = Difference between PWL and SWL, in feet
Flow = Calculated flow rate, in gallons per minute (gpm)
SC = Specific capacity, in gallons per minute per foot of drawdown
Est R('); Est R(") = Estimated radius of the well in feet; inches

Aquifer	City	Pumpid	Testdat	SWL	PWL	PWL-SWL	Flow	SC	Est R(')	Est R(")	T(art.)
E. Snake	Roberts	Well #3	19880626	64.4	87.6	23.2	727	31.3	1.00	12	55500
E. Snake	Shelley	Pump #4	19880525	103.0	144.6	41.6	1422	34.2	1.10	13.25	60200
E. Snake	Shelley	Pump #1	19880525	107.7	125.0	17.3	576	33.3	0.83	10	60800
E. Snake	Burley	#1	19890804	205.0	228.0	23.0	821	35.7	1.00	12	63800
E. Snake	Ashton	#1	19890912	28.0	44.0	16.0	900	56.3	1.00	12	103000
E. Snake	Aberdeen	Well #2	19870604	25.0	33.0	8.0	634	79.2	0.83	10	153000
E. Snake	Ammon	Well #6	19880524	86.0	102.2	16.2	1340	82.7	1.10	13.25	154000
E. Snake	Idaho Falls	Well #15 Main	19870626	106.0	124.0	18.0	2093	116.3	1.27	15.25	218000
E. Snake	Ririe	Pump #2	19871029	34.0	35.0	1.0	106	106.3	0.50	6	221000
E. Snake	Iona	Tank Pump	19870625	207.0	216.5	9.5	1312	138.1	1.27	15.25	261000
E. Snake	Rigby	Shop Well	19891018	15.0	22.0	7.0	1047	149.5	1.10	13.25	290000
E. Snake	Ammon	Well #7	19880524	65.0	74.4	9.4	1410	150.0	1.10	13.25	291000
E. Snake	Burley	#4	19890804	222.0	230.0	8.0	1227	153.3	1.17	14	295000
E. Snake	Rupert	Well #1	19890801	185.0	190.0	5.0	833	166.7	1.10	13.25	325000
E. Snake	Idaho Falls	Well #11 1435 RPM	19870624	195.0	208.0	13.0	3587	276.0	1.94	23.25	518000
E. Snake	Ririe	Pump #3	19871029	40.0	41.0	1.0	251	251.0	0.67	8	533000
E. Snake	Idaho Falls	Well #4 Main	19870623	155.0	172.0	17.0	4942	290.7	1.94	23.25	547000
E. Snake	Rigby	Well Pump #2	19891018	15.0	22.0	7.0	2441	348.8	1.27	15.25	700000
E. Snake	Idaho Falls	Well #11 1610 RPM	19870624	195.0	208.0	13.0	4861	373.9	1.10	13.25	767000
E. Snake	Dubois	Well #1	19891020	355.0	356.0	1.0	404	403.6	0.83	10	860000
E. Snake	Rigby	Harwood #3	19891018	15.0	16.0	1.0	420	419.9	0.83	10	896000
E. Snake	Dubois	Well #3	19891020	355.0	356.0	1.0	613	613.1	0.83	10	1330000
E. Snake	Shelley	Pump #3	19880525	92.6	95.7	3.1	1995	643.4	1.27	15.25	1340000
E. Snake	Shoshone	Pump #3	19871029	210.8	212.1	1.3	824	633.9	1.00	12	1350000
E. Snake	Rexburg	Well #5	19891017	324.0	327.0	3.0	2060	686.7	1.27	15.25	1430000
E. Snake	Rupert	Well #2'	19890801	185.0	187.0	2.0	1681	840.3	1.10	13.25	1800000
E. Snake	Rexburg	Well #1	19891017	208.0	210.0	2.0	2188	1093.8	1.27	15.25	2350000
E. Snake	Rexburg	Well #6	19891017	208.0	210.0	2.0	2246	1122.8	1.27	15.25	2410000
E. Snake	Jerome	Well Pump #2	19890816	284.8	285.8	1.0	1396	1396.4	1.27	15.25	3040000
E. Snake	Idaho Falls	Well #2 Main	19870622	167.0	169.0	2.0	2803	1401.3	1.27	15.25	3050000
E. Snake	Jerome	Well Pump #1	19890816	284.8	285.8	1.0	1493	1492.9	1.10	13.25	3310000
E. Snake	Idaho Falls	Well #3	19870626	165.0	166.0	1.0	4719	4718.6	1.94	23.25	1E+07
MVS-VS	Kuna	Process Pump	19880815	240.0	310.5	70.5	223	3.2	0.67	8	5030
MVS-VS	Kuna	Well #2	19880815	93.7	112.3	18.6	580	31.2	1.00	12	55300
MVS-VS	Kuna	Well #3	19880815	84.6	115.9	31.3	1801	57.5	1.27	15.25	102000
MVS-VS	Grandview	Pump #2	19880830	82.7	85.4	2.7	226	83.5	0.67	8	166000
MVS-VS	Grandview	Pump #1	19880830	79.7	82.1	2.4	246	102.5	0.67	8	206000
MVS-SED	Homedale	Well #2	19880602	44.2	222	178.1	198	1.1	0.5	6	1700
MVS-SED	Homedale	Old City Hall Well	19880602	41.8	216.0	174.2	206	1.2	0.67	8	1730
MVS-SED	Eagle	#2 Submersible	19910520	50.9	133.8	82.9	266	3.2	0.67	8	5100
MVS-SED	Nampa	Well #10	19880518	17.0	191.0	174.0	605	3.5	0.83	10	5380
MVS-SED	Caldwell	Well #9 1670 RPM	19880816	50.5	233.2	182.7	779	4.3	1.00	12	6510
MVS-SED	Caldwell	Well #13	19880816	10.7	149.5	138.8	772	5.6	1.00	12	8680
MVS-SED	Caldwell	Well #10	19880816	11.6	145.0	133.4	751	5.6	1.00	12	8790
MVS-SED	Homedale	Park Well	19880602	4.6	42.5	37.9	207	5.5	0.67	8	9050
MVS-SED	Nampa	Well #8	19880517	56.1	171.2	115.1	862	7.5	1.10	13.25	11700
MVS-SED	Caldwell	Well #7 1870 RPM	19880816	6.0	110.0	104.0	889	8.5	1.00	12	13700
MVS-SED	Parma	Well #7	19880826	24.5	138.4	113.9	1033	9.1	1.10	13.25	14400
MVS-SED	Caldwell	Well #11	19880816	10.6	112.2	101.6	986	9.7	1.00	12	15800
MVS-SED	Wilder	Pump #2	19880823	98.0	132.0	34.0	337	9.9	0.83	10	16600
MVS-SED	Caldwell	Well #6	19880816	9.5	90.0	80.5	864	10.7	1.00	12	17600

Header Explanation for Table F- 1

Aquifer = Aquifer Name
- Alluv = Unconsolidated Alluvium
- CR Basalt = Columbia River Basalts
- E. Snake = Eastern Snake River Plain Basalts
- MVS-VS = Mixed Volcanic and Sedimentary Rocks, Primarily Volcanic Rocks
- MVS-Sed = Mixed Volcanic and Sedimentary Rocks, Primarily Sedimentary Rocks
- Rathdrum = Rathdrum Prairie Aquifer

City = City location of the well
Pumpid = Well identification
SWL = Static water level, in feet
PWL = Pumping water level, in feet
PWL-SWL = Difference between PWL and SWL, in feet
Flow = Calculated flow rate, in gallons per minute (gpm)
SC = Specific capacity, in gallons per minute per foot of drawdown
Est R('); Est R(") = Estimated radius of the well in feet; inches
T(art.) = Transmissivity, in gallons per day per foot (gpd/ft)
(Uses confined aquifer storage coefficient)

Idaho Wellhead Protection Plan

Aquifer	City	Pumpid	Testdat	SWL	PWL	PWL-SWL	Flow	SC	Est R(')	Est R(")	T(art.)
MVS-SED	Caldwell	Well #14	19880817	34.9	85.8	50.9	679	13.3	0.83	10	22800
MVS-SED	Garden City	#1	19890726	132.5	160.0	27.5	368	13.4	0.83	10	22900
MVS-SED	Caldwell	Well #8 1200 RPM	19880817	9.4	39.4	30.0	566	18.9	1.00	12	32200
MVS-SED	Notus	#2	19890524	30.0	55.0	25.0	490	19.6	0.83	10	34500
MVS-SED	Nampa	Colorado	19880619	9.5	45.0	35.5	774	21.8	1.00	12	37700
MVS-SED	Nampa	Well #7	19880518	11.3	41.8	30.5	823	27.0	1.10	13.25	467o0
MVS-SED	Nampa	Well #9 1280 RPM	19880518	1.0	18.5	17.5	458	26.2	0.83	10	47000
MVS-SED	Eagle	#1 Submersible	19910520	40.0	59.0	19.0	539	28.4	0.83	10	51200
MVS-SED	Garden City	#5 (Variable Speed)	19890726	22.0	36.0	14.0	490	35.0	0.83	10	64100
MVS-SED	Middleton	Pump #4	19890808	86.0	135.0	49.0	1903	38.8	1.27	15.25	87600
MVS-SED	Nampa	Well #6	19880517	32.0	49.0	17.0	830	48.8	1.10	13.25	88100
MVS-SED	Caldwell	Well #4	19880817	74.0	80.3	6.3	295	46.9	0.67	8	89900
MVS-SED	Garden City	#43	19890727	15.0	35.0	20.0	1219	60.9	1.10	13.25	111000
MVS-SED	Nampa	Holly	19880619	17.3	27.5	10.2	695	68.1	1.00	12	127000
MVS-SED	Eagle	#3 Submersible	19910520	65.5	69.2	3.7	259	69.9	0.67	8	137000
MVS-SED	Nampa	19th Ave. N.	19880619	3.1	10.0	6.9	591	85.6	1.00	12	162000
MVS-SED	Nampa	Venice	19880519	16.8	22.0	5.2	462	88.8	0.83	10	172000
MVS-SED	Nampa	Juniper Square	19880619	23.0	24.0	1.0	137	137.1	0.50	6	290000
Rathdrum	Coeur d'Alene	Atlas Road Well	19870804	241.0	245.0	4.0	1155	288.7	1.10	13.25	58300
Rathdrum	Coeur d'Alene	Fourth St. Well	19870804	194.5	212.0	17.5	3238	185.0	1.60	19.25	347000
Rathdrum	Coeur d'Alene	Linden St. Well	19870804	169.0	178.0	9.0	2604	289.3	1.27	15.25	574000
Rathdrum	Coeur d'Alene	Atlas Road Well		241.0	245.0	4.0	1155	288.8	1.10	13.25	583000
Rathdrum	Coeur d'Alene	Locust St. Well	19870804	174.0	175.8	1.8	1655	919.7	1.10	13.25	1960000

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SC = Specific capacity, in gallons per minute per foot of drawdown
Est R('); Est R(") = Estimated radius of the well in feet; inches
T(art.) = Transmissivity, in gallons per day per foot (gpd/ft)
(Uses confined aquifer storage coefficient)

Idaho Wellhead Protection Plan

A.7 Hydraulic Conductivities by Rock Type

Table A-7.Hydraulic Conductivity Values—Eastern Snake River Plain (feet/second).

Hydraulic Conductivity Values - Eastern Snake River Plain (From Table 19, Garabedian 1989)					
	Basalt	Sand and gravel	Sand	Clay and Silt	Silicic Volcanics (rhyolite)
Zone No.	(x 10^{-4})	(x 10^{-4})	(x 10^{-4})	(x 10^{-6})	(x 10^{-6})
			feet/second		
1	0.052	11	0.11	2.3	7.5
2	5.5	90	0.90	0.75	7.5
3	550	73	0.73	2.3	7.5
4	0.9	17	0.17	0.75	7.5
5	803	110	1.1	2.3	7.5
6	2.4	47	0.63	2.3	7.5
7	2.1	41	0.41	2.3	7.5
8	56	140	1.4	0.38	7.5
9	0.75	7.5	0.075	0.75	7.5
10	5.7	110	1.1	0.75	7.5
11	3.8	3.8	3.8	0.38	7.5
12	23	75	0.75	2.3	7.5
13	580	2,000	0.1	0.38	7.5
14	1,100	1,900	1.9	2.3	7.5
15	11	71	0.71	0.38	7.5
16	230	38	0.38	2.3	7.5
17	61	330	0.66	2.3	7.5
18	6	11	1.1	2.3	7.5
19	670	1,700	1.7	2.3	7.5
20	150	71	0.71	2.3	7.5
21	590	83	0.83	2.3	7.5
22	50	29	0.29	0.38	7.5
23	120	83	0.83	2.3	7.5
24	440	83	0.83	2.3	7.5
25	2.9	59	0.59	2.3	7.5
26	200	48	0.48	2.3	7.5
27	68	47	0.62	2.3	7.5
28	3	58	0.58	2.3	7.5
29	1.5	31	0.31	0.75	7.5
30	3.9	11	0.11	0.38	7.5
31	1.6	26	0.26	0.75	7.5
32	380	38	0.38	2.3	7.5
33	420	210	2.1	2.3	7.5
34	250	300	0.30	2.3	7.5
35	66	140	66	0.38	7.5
36	600	1,500	600	7.5	7.5
37	15	15	0.23	2.3	7.5
38	150	83	0.83	3.8	7.5
39	120	18	0.18	2.3	7.5

Table A-8. Hydraulic Conductivity Values—Eastern Snake River Plain (feet/day).

Hydraulic Conductivity Values - Eastern Snake River Plain (From Table 19, Garabedian 1989)					
Zone No.	Basalt	Sand and gravel	Sand	Clay and Silt	Silicic Volcanics (rhyolite)
			feet/day		
1	0.45	95.0	0.95	0.20	0.65
2	47.5	778	7.78	0.06	0.65
3	4752	631	6.31	0.20	0.65
4	7.78	147	1.47	0.06	0.65
5	6938	950	9.50	0.20	0.65
6	20.7	406	5.44	0.20	0.65
7	18.1	354	3.54	0.20	0.65
8	484	1210	12.1	0.03	0.65
9	6.48	64.8	0.65	0.06	0.65
10	49.2	950	9.50	0.06	0.65
11	32.8	32.8	32.8	0.03	0.65
12	199	648	6.48	0.20	0.65
13	5011	17280	0.86	0.03	0.65
14	9504	16416	16.4	0.20	0.65
15	95.0	613	6.13	0.03	0.65
16	1987	328	3.28	0.20	0.65
17	527	2851	5.70	0.20	0.65
18	51.8	95.0	9.50	0.20	0.65
19	5789	14688	14.7	0.20	0.65
20	1296	613	6.13	0.20	0.65
21	5098	717	7.17	0.20	0.65
22	432	251	2.51	0.03	0.65
23	1037	717	7.17	0.20	0.65
24	3802	717	7.17	0.20	0.65
25	25.1	510	5.10	0.20	0.65
26	1728	415	4.15	0.20	0.65
27	588	406	5.36	0.20	0.65
28	25.9	501	5.01	0.20	0.65
29	13.0	268	2.68	0.06	0.65
30	33.7	95.0	0.95	0.03	0.65
31	13.82	225	2.25	0.06	0.65
32	3283	328	3.28	0.20	0.65
33	3629	1814	18.1	0.20	0.65
34	2160	2592	2.59	0.20	0.65
35	570	1210	570	0.03	0.65
36	5184	12960	5184	0.65	0.65
37	130	130	1.99	0.20	0.65
38	1296	717	7.17	0.33	0.65
39	1037	156	1.56	0.20	0.65
40	1728	2246	2.25	0.20	0.65

A.8 Hydraulic Conductivity Zones; East Snake River Plain

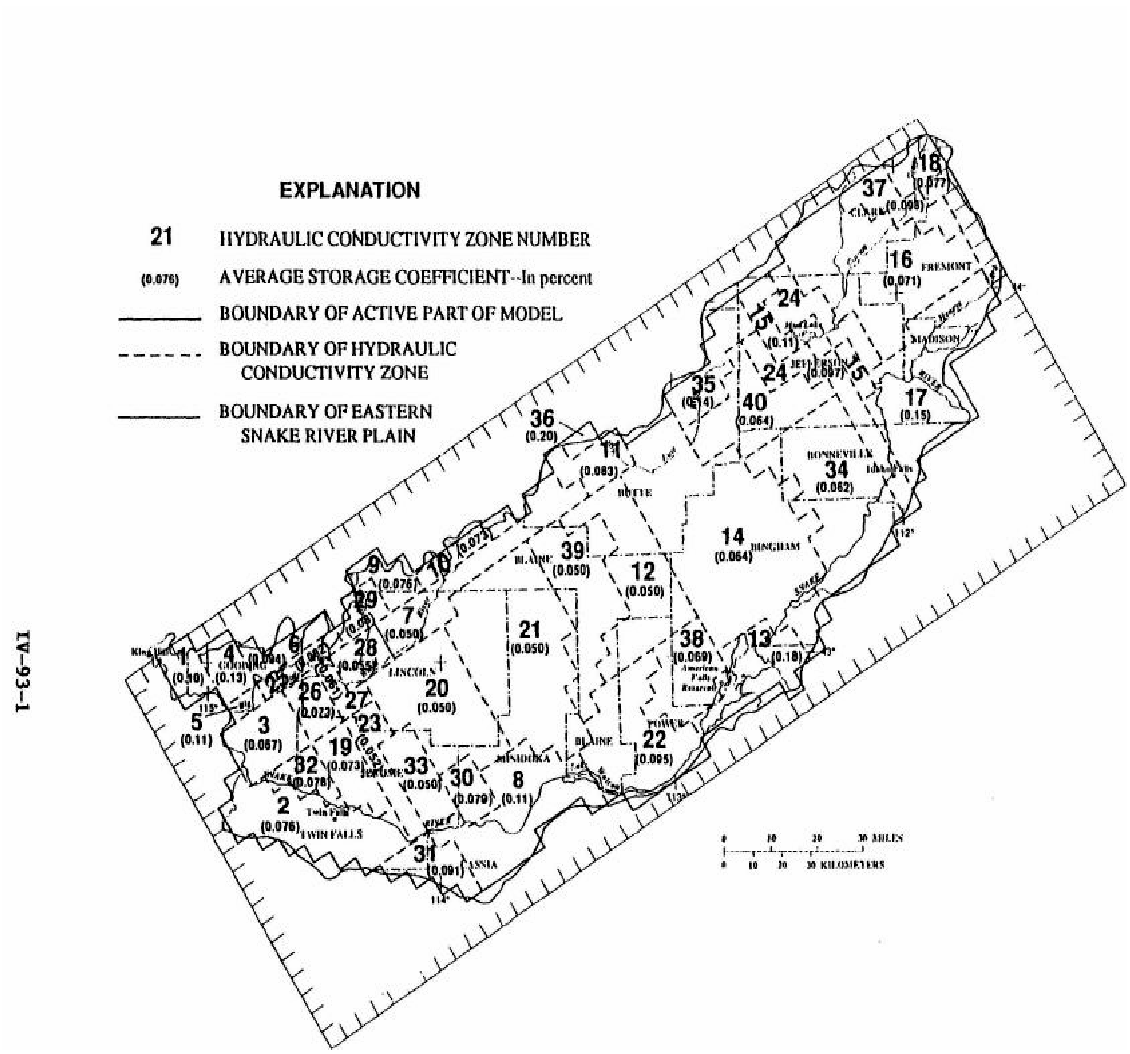

Figure A-1. Hydraulic Conductivity zones and average storage coefficients, model level 1

A.9 Hydraulic Conductivity and Permeability

Table 2.2 Range of Values of Hydraulic Conductivity and Permeability

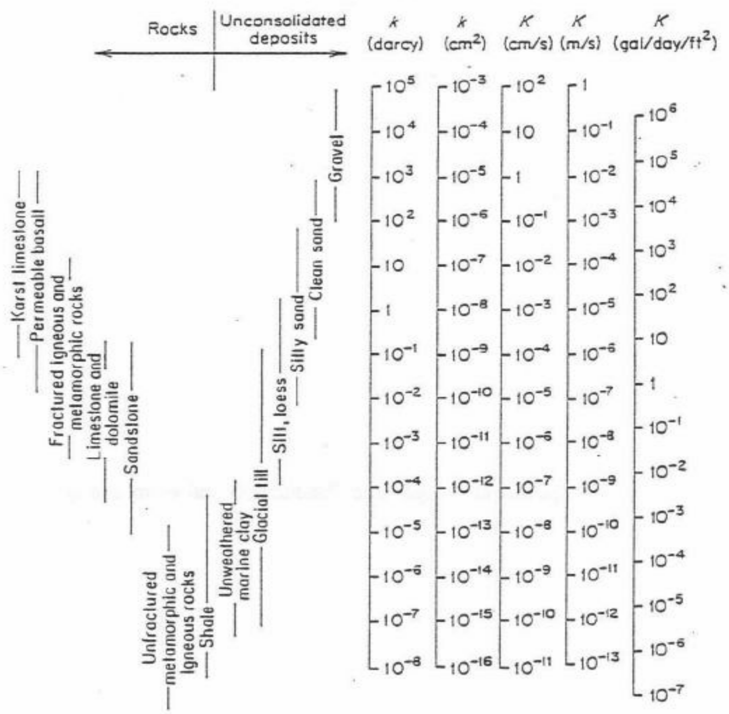

Table 2.3 Conversion Factors for Permeability and Hydraulic Conductivity Units

	Permeability, k*			Hydraulic conductivity, K		
	cm²	ft²	darcy	m/s	ft/s	gal/day/ft²
cm²	1	1.08×10^{-3}	1.01×10^{8}	9.80×10^{2}	3.22×10^{3}	1.85×10^{9}
ft²	9.29×10^{2}	1	9.42×10^{10}	9.11×10^{5}	2.99×10^{6}	1.71×10^{12}
darcy	9.87×10^{-9}	1.06×10^{-11}	1	9.66×10^{-6}	3.17×10^{-5}	1.82×10^{1}
m/s	1.02×10^{-3}	1.10×10^{-6}	1.04×10^{5}	1	3.28	2.12×10^{6}
ft/s	3.11×10^{-4}	3.35×10^{-7}	3.15×10^{4}	3.05×10^{-1}	1	5.74×10^{5}
gal/day/ft²	5.42×10^{-10}	5.83×10^{-13}	5.49×10^{-2}	4.72×10^{-7}	1.74×10^{-6}	1

*To obtain k in ft², multiply k in cm² by 1.08×10^{-3}.

Freeze and Cherry, 1979, Groundwater - Chapter 2, page 29, Tables 2.2 and 2.3

IV–94–1

Figure A-2. Hydraulic Conductivity and Permeability

A.10 Ground Water Quality

NOT INCLUDED IN THIS DRAFT

A.10.1 Nutrient – Pathogen Studies

NOT INCLUDED IN THIS DRAFT

A.10.2 Interim Guidance on the Ground Water Quality Rule

NOT INCLUDED IN THIS DRAFT

A.10.3 Rule

NOT INCLUDED IN THIS DRAFT

A.11 Standard Permits

NOT INCLUDED IN THIS DRAFT

A.11.1 Performance Standard Permits

TBD - NOT INCLUDED IN THIS DRAFT

A.11.2 Standard Municipal Permits

User's Guide
for the
Standard Municipal Wastewater-Land Application Permit Template

02/15/04

Introduction

The Standard Municipal Wastewater Land Application Permit Template is a guidance document for writing Municipal permits. There may be permit specific issues that are not addressed in this template or parts of the template that may not be applicable to the site you are permitting. The template serves to provide for consistent permit limits and language where appropriate.

The template includes a section for abbreviations/acronyms and the layout is arranged to put permit specific information at the beginning and standard limits, requirements, and conditions towards the end of the permit.

The language that appears in yellow highlight is optional and inclusion in the permit needs to be evaluated on a case-by-case basis by the permit writer.

The Wastewater Program Office, as time permits, will update this template. If you have suggestions for modifying the template, please contact Mark Mason at (208) 373-0266.

Section E. Compliance Schedule for Required Activities

Plan of Operation – Inclusion of this compliance activity will depend on the status of the Plan of Operation at the time of permitting. If an existing facility has an adequate Plan of Operation, this is obviously not necessary. For new facilities or re-permits involving significant modifications, this requirement may be appropriate.

Nuisance Odor Management Plan – Preference would be to have the applicant submit this plan with permit application materials, especially for new systems or if there is significant public interest.

TDIS Management Plan – If ground water modeling indicates significant TDS impacts to ground water, this compliance activity should be included.

Water Quality Improvement Plan (WQIP) – For sites that have existing ground water quality that exceeds the limits in the *Ground Water Quality Rule* (IDAPA 58.01.11) for primary or secondary standards as a result of land application activities, a WQIP may be required. The WQIP requires mapping areas where ground water has been impacted. For areas where ground water quality standards are exceeded, a plan to improve ground water quality, with the objective of attaining standards is required. For areas where ground water quality is degraded, but ground water quality standards are not exceeded, best management practices or other measures described in the

GWQR, section 58.01.11.400.02 shall be developed and implemented. For example language, consult with the Wastewater Program Office.

Waste Solids Management Plan – Site specific.

Buffer Zone Plan – The applicant should provide this information as part of the permit application materials. However, for new sites that are in design, this compliance activity may be required. Facilities may be developing plans for the irrigation system during the same timeframe as the draft permit.

Ground Water Monitoring Plan – Site specific. Typically required for new facilities where it is determined ground water monitoring is necessary. May also be required for re-permitting sites in which the existing network is inadequate.

Section F. Special Permit Conditions

Supervision – Requiring supervision of the wastewater treatment system is optional. Poor past management or complex wastewater pretreatment systems prior to land application are considerations. Also helpful for simple systems where operator is not technically proficient.

Section G. Monitoring Requirements

Composite Sampling - Dependent on wastewater system. For systems with wastewater quality that is variable within a 24-hour period, the system should provide composite samples. For systems that quality does not vary significantly on a daily basis, grab samples are appropriate.

Bacterial Sampling – Required.

Appendix 1. Environmental Monitoring Serial Numbers

Instructions for serial number assignment. Serial Numbers for monitoring points are formatted as follows. XX-xxxxxx. The upper case XX signifies the type of point (MU, WW, SW…). This is followed by a hyphen. The first four lower case x's signify the last four numbers of the permit, excluding the suffix. The last two lower case x's signify the actual point location. If the permit area expands over the life of the project, the point location numbers are just continued and expanded as necessary. No allowance is necessary for suffixes or new expansion area designation.

A. Permit Certificate

MUNICIPAL
WASTEWATER-LAND APPLICATION PERMIT
LA-000xxx-0x

Facility Name, LOCATED AT Street address, city, ID xxxxx-xxxx AND IN **Township(s) xx, Range(s) xx, Section(s) xx IS** HEREBY AUTHORIZED TO CONSTRUCT, INSTALL, AND OPERATE A WASTEWATER-LAND APPLICATION SYSTEM IN ACCORDANCE WITH THE WASTEWATER-LAND APPLICATION RULES (IDAPA 58.01.17), THE WATER QUALITY STANDARDS AND WASTEWATER TREATMENT REQUIREMENTS (IDAPA 58.01.02), THE GROUND WATER QUALITY RULE (IDAPA 58.01.11), AND ACCOMPANYING PERMIT, APPENDICES, AND REFERENCE DOCUMENTS. THIS PERMIT IS EFFECTIVE FROM THE DATE OF SIGNATURE AND EXPIRES ON **(60 months from issue date)**.

Name of RO Administrator
Title i.e. (REGION) Regional Administrator
Idaho Department of Environmental Quality

Date:

DEPARTMENT OF ENVIRONMENTAL QUALITY
Regional Office Address
Regional Office Phone No.

POSTING ON SITE RECOMMENDED

B. Permit Contents, Appendices, and Reference Documents

Appendices

1. Environmental Monitoring Serial Numbers
2. Site Maps

References

1. Plan of Operation (Operation and Maintenance Manual)
   - Nuisance Odor Management Plan
   - Waste Solids Management Plan
   - Etc. – see checklist in Handbook

The Sections, Appendices, and Reference Documents listed on this page are all elements of Wastewater-Land Application Permit LA-000xxx-0x and are enforceable as such. This permit does not relieve Company Name, hereafter referred to as the permittee, from responsibility for compliance with other applicable federal, state or local laws, rules, standards or ordinances.

LA-000xxx-0x	**Facility Name**	**Date**	**Page 4**

C. Abbreviations, Definitions

Comment: Items throughout template that are highlighted in yellow are options for considerations and additional thought as to application to a particular permit. Those items may be included, modified or deleted.

Ac-in	Acre-inch. The volume of water or wastewater to cover 1 acre of land to a depth of 1 inch. Equal to 27,154 gallons.
BMP or BMPs	Best Management Practices
COD	Chemical Oxygen Demand
DEQ or the Department	Idaho Department of Environmental Quality
Director	Director of the Idaho Department of Environmental Quality, or the Directors Designee, i.e. Regional Administrator
ET	Evapotranspiration – Loss of water from the soil and vegetation by evaporation and by plant uptake (transpiration)
GS	Growing Season – Typically April 01 through October 31 (214 days)
GW	Ground Water
GWQR	IDAPA 58.01.11 "Ground Water Quality Rule"
Guidelines	Guidance for Land Application of Municipal and Industrial Wastewater, DEQ
HLRgs	Growing Season Hydraulic Loading Rate. Includes any combination of wastewater and supplemental irrigation water applied to land application hydraulic management units during the growing season. The HLRgs limit is specified in Section F. Permit Limits and Conditions.
HLRngs	Non-Growing Season Hydraulic Loading Rate. Includes any combination of wastewater and supplemental irrigation water applied to each hydraulic management unit during the non-growing season. The HLRngs limit is specified in Section F. Permit Limits and Conditions.
HMU	Hydraulic Management Unit (Serial Number designation is MU)
IWR	Irrigation Water Requirement – Any combination of wastewater and supplemental irrigation water applied at rates commensurate to the moisture requirements of the crop, and calculated monthly during the growing season (GS). Calculation methodology for the IWR can be found at the following website: http://www.kimberly.uidaho.edu/water/appndxet/index.shtml. The equation used to calculate the IWR at this website is: $IWR = (CU - P_e) / E_i$ CU is the monthly consumptive use for a given crop in a given climatic area. CU is synonymous with crop evapotranspiration P_e is the effective precipitation. CU minus Pe is synonymous with the net irrigation requirement (IR) E_i is the irrigation system efficiency. To obtain the gross irrigation water requirement (IWR), divide the IR by the irrigation system efficiency.
IDAPA	Idaho Administrative Procedures Act
LG	Lagoon
lb/ac-day	Pounds (of constituent) per acre per day
MG	Million Gallons (1 MG = 36.827 acre-inches)
MGA	Million Gallons Annually (per WLAP Reporting Year)
NGS	Non-Growing Season – Typically November 01 through March 31 (151 days)
NVDS	Non-Volatile Dissolved Solids (= Total Dissolved Solids less Volatile Dissolved Solids)
O&M manual	Operation and Maintenance Manual, also referred to as the Plan of Operation

LA-000xxx-0x	**Facility Name**	**Date**	**Page 5**

C. Abbreviations, Definitions

SAR	Sodium Absorption Ratio
SI	Supplemental Irrigation water applied to the land application treatment site.
Soil AWC	Soil Available Water Holding Capacity - the water storage capability of a soil to a depth at which plant roots will utilize (typically 60 inches or root limiting layer)
SMU	Soil Monitoring Unit (Serial Number designation is SU)
SW	Surface Water
TDS	Total Dissolved Solids or Total Filterable Residue
TDIS	Total Dissolved Inorganic Solids – The summation of chemical concentration results in mg/L for the following common ions: calcium, magnesium, potassium, sodium, chloride, sulfate, and 0.6 times alkalinity (alkalinity expressed as calcium carbonate). Nitrate, Silica and fluoride shall be included if present in significant quantities (i.e. > 5 mg/L each).
TMDL	Total Maximum Daily Load – The sum of the individual waste-load allocations (WLA's) for point sources, Load Allocations (LA's) for non-point sources, and natural background. Such load shall be established at a level necessary to implement the applicable water quality standards with seasonal variations and a margin of safety that takes into account any lack of knowledge concerning the relationship between effluent limitations and water quality. IDAPA 58.01.02 *Water Quality Standards and Wastewater Treatment Requirements*
Typical Crop Uptake	Typical Crop Uptake is defined as the median constituent crop uptake from the three (3) most recent years the crop has been grown. Typical Crop Uptake is determined for each hydraulic management unit. For new crops having less than three years of on-site crop uptake data, regional crop yield data and typical nutrient content values, or other values approved by DEQ may be used.
USGS	United States Geological Survey
WLAP	Wastewater Land Application Permit (or Program)
WLAP Reporting Year	The reporting year begins with the non-growing season and extends through the growing season of the following year, typically November 01 – October 31. For example, the 2000 Reporting Year was November 01, 1999 through October 31, 2000.
WW	Wastewater applied to the land application treatment site

LA-000xxx-0x	**Facility Name**	**Date**	**Page 6**

D. Facility Information

Legal Name of Permittee	
Type of Wastewater	
Method of Treatment	
Type of Facility	
Facility Location	
Legal Location	
County	
USGS Quad	
Soils on Site	
Depth to Ground Water	
Beneficial Uses of Ground Water	
Nearest Surface Water	
Beneficial Uses of Surface Water	
Responsible Official Mailing Address **Phone / Fax**	
Facility Consultants Mailing Address **Phone / Fax**	

LA-000xxx-0x	**Facility Name**	**Date**	**Page 7**

E. Compliance Schedule for Required Activities

Optional items to be edited are highlighted in yellow.

The Activities in the following table shall be completed on or before the Completion Date unless modified by the Department in writing.

Compliance Activity Number Completion Date	Compliance Activity Description
CA-xxx-xx **Prior to applying wastewater at site**	A Plan of Operation (Operation and Maintenance Manual or O&M Manual) for the wastewater land application facilities, incorporating the requirements of this permit, shall be submitted to DEQ for review and comment. The O&M manual shall be designed for use as an operator guide for actual day-to-day operations to meet permit requirements and shall include daily sampling and monitoring requirements to insure proper operation of the wastewater treatment facility. The Plan of Operation shall contain at a minimum all of the information required by the latest revision of the Plan of Operation Checklist in the WLAP Program Guidance. Upon approval, the manual shall be incorporated by reference into this permit and shall be enforceable as a part of this permit.
CA-xxx-xx **Prior to applying wastewater at site**	Submit a Nuisance Odor Management Plan to DEQ for review and approval. The Odor Management Plan shall include wastewater treatment systems, land application facilities, and other operations associated with the facility. The plan shall include specific design considerations, operation and maintenance procedures, and management practices to be employed to minimize the potential for or limit odors. The plan shall also include procedures to respond to an odor incident if one occurs, including notification procedures.
CA-xxx-xx **Prior to applying wastewater at site**	A TDIS Management Plan may be required if ground water TDS significantly increases across the site. The plan shall identify sources of TDIS, evaluate the feasibility of isolation or removal of TDIS, and propose strategies to minimize TDIS in the wastewater.
CA-xxx-xx **Prior to applying wastewater at site**	For sites that have existing ground water quality that exceeds standards as a result of land application activities, a Water Quality Improvement Plan (WQIP) may be required.
CA-xxx-xx **Prior to applying wastewater at site**	Submit to the Department for review and approval, a well location acceptability analysis, as outlined in the *Guidance for Land Application of Municipal and Industrial Wastewater*, Section 6.6.3.1 for all applicable wells located around or on the land application site.
CA-xxx-xx **Prior to application of waste solids**	Submit a Waste Solids Management Plan to DEQ for review and approval. The Plan shall describe how waste solids generated at the facility will be handled and disposed of to meet the requirements of section I, No. 5.

LA-000xxx-0x	**Facility Name**	**Date**	**Page 8**

E. Compliance Schedule for Required Activities

Compliance Activity Number Completion Date	Compliance Activity Description
CA-xxx-xx Prior to applying wastewater at site	Submit a scaled site map delineating buffer zones, homes, public access areas, private wells, canals, etc. and the actual area in acres of each HMU. Site Maps shall be supplied by the permittee and shall include at a minimum all requirements of IDAPA 58.01.17.300.05.e through f.
CA-xxx-xx Prior to applying wastewater at site	Submit plans and specifications for ground water monitoring network for DEQ review and approval, including at least one (1) upgradient well and two (2) downgradient wells.
CA-xxx-xx Prior to applying wastewater at site	For Forest / Tree sites, Permittee shall submit Silviculture Plan to DEQ within 12 months of permit start date.
CA-xxx-xx Within one year of permit renewal	Update O & M Manual, Site Maps etc.

(Add other optional requirements for grazing plans, and seepage testing here in compliance activities to further describe particular requirements for each site.)

LA-000xxx-0x	Facility Name	Date	Page 9

F. Permit Limits and Conditions

1) The Permittee is allowed to apply wastewater and treat it on a land application site as prescribed in the tables below and in accordance with all other applicable permit conditions and schedules.

Category	Permitted Limits and Conditions
Type of Wastewater	Municipal Wastewater
Application Site Area	
Application Season	
Growing Season (GS)	Site Specific – see definitions, abbreviations
Non-Growing Season (NGS)	Site Specific – see definitions, abbreviations
Certified Operator	Required. See IDAPA 58.01.02.406.
Reporting Year for Annual Loading Rates	Site Specific Dates. Comment: It should always be consecutive NGS and GS periods.
Maximum Hydraulic Loading Rate, Growing Season (includes wastewater and supplemental irrigation water, if used)	Growing Season (GS) Hydraulic Loading Rate shall be no greater than the Irrigation Water Requirement (IWR) using data from the tables of the following University Of Idaho web site: http://www.kimberly.uidaho.edu/water/appndxet/index.shtml. IWR is equal to the Mean IR data from these tables divided by the irrigation system efficiency. In lieu of these tables, current climatic and evaporation data, or 30-year average data may be used to calculate the IWR, as defined in the 1994 Technical Interpretive Supplement, pages IV-6 and IV-7. Assume no carryover soil moisture and a leaching rate of zero in calculating the IWR. Application shall generally follow consumptive use rates for the crop throughout the season.
Maximum Hydraulic Loading Rate, Non-Growing Season	Soil AWC – Precipitation $_{NGS}$ + Evapotranspiration $_{NGS}$ for each hydraulic management unit (HMU). **Include the allowable amount in inches and MG for each HMU in this section based on this equation.** HMU # / Field Description / Million Gallons / Inches 1 / Pivots 1 and 2 / x.xx / x.xx 2 / Pivot 3 / x.xx / x.xx etc.…
No Runoff	______ shall prepare and submit to DEQ for approval a runoff management plan with control structures and other BMPs (e.g. collection basins, berms, etc.) designed to prevent runoff from any site or fields used for wastewater land application to property not owned by ______ except in the event of a 25-year, 24-hour storm event or greater, using Western Regional Climate Center (WRCC) Precipitation Frequency Map, Figure 28 'Isopluvials of 25-YR, 24-HR Precipitation'. For this site, the 25-year, 24-hour event is ___ inches. Upon approval of the plan by DEQ, ______ shall implement the runoff management plan, and shall construct, operate, and maintain the control structures and other BMPs in accordance with the plan.
Ground Water Quality	Ground Water Quality shall be in compliance with *Idaho Ground Water Quality Rule* IDAPA 58.01.11

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F. Permit Limits and Conditions

Category	Permitted Limits and Conditions
Maximum COD Loading, seasonal average in Pounds / acre-day, each HMU	50 pounds/acre-day seasonal average for growing season. 25 pounds/acre-day seasonal average for non-growing season.
Maximum Nitrogen Loading Rate, pounds / acre-year, each HMU (from all sources including waste solids and supplemental fertilizers).	150% of typical crop uptake (see definition), or UI Fertility Guide
Maximum Phosphorus Loading Rate, pounds / acre-year, each HMU (from all sources including waste solids and supplemental fertilizers).	None. DEQ reserves the right to re-open this permit for inclusion of phosphorus limits.
Construction Plans	Prior to construction or modification of all wastewater facilities associated with the land application system or expansion, detailed plans and specifications shall be reviewed and approved by DEQ. Within 30 days of completion of construction, the permittee shall submit as-built plans for review and approval.
Grazing	A grazing management plan shall be submitted to DEQ for review and approval prior to any grazing activities. Grazing Plans shall follow the guidance located on the DEQ Internet site.
Allowable crops	Crops grown for direct human consumption (those crops that are not processed prior to consumption) are not allowed.
Fencing and Posting	Signs shall be posted every 500 feet designating the fields as wastewater reuse areas or equivalent – see WLAP Guidance.
Supplemental Irrigation Water Protection	For systems with wastewater and fresh irrigation water interconnections, DEQ approved backflow prevention devices are required.
Odor Management	The wastewater treatment plant, land application facilities, and other operations associated with the facility shall not create a public health hazard or nuisance conditions, including odors. These facilities shall be managed in accordance with a

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F. Permit Limits and Conditions

Category	Permitted Limits and Conditions
	DEQ approved Odor Management Plan.

Buffer Zone Distances (based on sprinkler irrigation)	Disinfection Level* (total coliform)	Distance to Public Access	Distances to Inhabited Dwellings	Distance to streams	Distance to private water sources	Distance to public water sources	Single sample maximum total coliform level
	2.2 /100 ml	0 feet	100 feet	100 feet	500	1000	23/100 ml
	23/100 ml	50 feet	300 feet	100 feet	500	1000	240/100ml
	230/100ml	300 feet	1,000 feet	100 feet	500	1000	2400/100ml

*Compliance determination method for disinfection requirements is as follows:

- For determining compliance with the 2.2 / 100 ml disinfection level, the median value of the last five (5) results must not exceed 2.2 / 100 ml. In addition, no single sample value shall exceed 23 / 100 ml.
- For determining compliance with the 23 / 100 ml disinfection level, the median value of the last five (5) results must not exceed 23 / 100 ml. In addition, no single sample value shall exceed 240 / 100 ml.
- For determining compliance with the 230 / 100 ml disinfection level, the median value of the last three (3) results must not exceed 230 / 100 ml. In addition, no single sample value shall exceed 2400 / 100 ml.

(Also see Guidance for additional requirements for Buffer Zones – Public Exposure and Buffer Zones – Well Head Protection.)

The following are possible Permit Limits and Conditions that would be chosen depending on the particular permit is question. Many other options are available as the permit writer sees necessary.

1. No wastewater land application is allowed when depth to ground water is 36 inches or less as measured by on-site piezometers.
2. Specific total coliform limit and associated buffer zones.
3. More defined Hydraulic Loading Requirement. In the Cd'A permits, we calculated the monthly IWR in inches and MG, and put those in the permit.
4. Discussion of weekly or monthly limits on hydraulic loading.

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F. Permit Limits and Conditions

5. Other applicable issues.

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G. Monitoring Requirements

1) Appropriate analytical methods, as given in the *Guidance for Land Application of Municipal and Industrial Wastewater* or as approved by the Idaho Department of Environmental Quality (hereinafter referred to as DEQ), shall be employed. A description of approved sample collection methods, appropriate analytical methods and companion QA/QC protocol shall be included in the Operation and Maintenance Manual.
2) The permittee shall monitor and measure parameters and submit information as stated in the Facility Monitoring Table in this section.
3) Samples shall be collected at times and locations that represent typical environmental and process parameters being monitored.
4) Monitoring locations are described in Appendix 1. Environmental Monitoring Serial Numbers.
5) Monitoring is required at the frequency shown in the table below if wastewater is applied anytime during the time period shown. Unless otherwise agreed in writing by the DEQ, data collected and submitted shall include, but not be limited to, the parameters and frequencies in the Facility Monitoring Table as follows.
6) If the soil management unit is less than 15 acres, use 5 sub-samples. If the soil management unit is greater than 15 acres, use 10 sub-samples.
7) Three (3) soil samples shall be collected at each sample location, one at 0-12 inches, one at 12-24 inches, and one at 24-36 inches. The soil samples collected at 0-12 inches from each sample location shall be composited. Similarly, all soil samples collected at 12-24 inches shall be composited and all soil samples collected at 24-36 inches shall be composited. This method will yield three samples for analysis, one for 0-12 inches, one for 12-24 inches and one for 24-36 inches for each soil management unit.
8) Ground Water Monitoring Procedure: Ground Water Monitoring Wells shall be purged a minimum of three casing volumes and/or until field measurements for pH, specific conductance and temperature meet the following conditions: two successive temperature values measured at least five minutes apart are within one degree Celsius of each other, pH values for two successive measurements measured at least five minutes apart are within 0.2 units of each other, and two successive specific conductance values measured at least five minutes apart are within 10% of each other. This procedure will determine when the wells are suitable for sampling for constituents required by the permit. Other procedures, such as low flow sampling, may be considered by DEQ for approval. The static water level shall be measured prior to pumping or sampling for ground water.
9) Annual reporting of monitoring requirements is described in Section H, Standard Reporting Requirements.
10) Surface water sampling guidance: DEQ to review and approve methods, timing and locations for sampling prior to initial sampling event.

Facility Monitoring Table

Frequency	Monitoring Point	Description and Type of Monitoring	Parameters
Daily (when land applying)	Discharge Point of Wastewater to Land Application (Flow Meter)	Volume of Wastewater land applied	Gallons/Month and acre-inches/month applied to each Hydraulic Management Unit
Monthly (when land applying)	Discharge Point of Wastewater to Land Application	grab sample	Total Kjeldahl nitrogen, nitrate+nitrite-nitrogen, TDS, pH, COD, total phosphorus
Daily (when land applying)	Flow Meter or Calibrated Pump Rate	Supplemental Irrigation Water	Gallons/Month and acre-inches/month applied to each Hydraulic Management Unit
Annually	Supplemental Irrigation Water	Grab Sample	Total Kjeldahl nitrogen, nitrate+nitrite-nitrogen, TDS,

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G. Monitoring Requirements

Frequency	Monitoring Point	Description and Type of Monitoring	Parameters
	at diversions		pH, COD, total phosphorus
During Application Season For total coliform, monitoring frequency depends on level of treatment 1. 2.2 / 100 ml. - Twice Weekly 2. 23 / 100 ml. - Weekly 3. 230 / 100 ml. - Twice Monthly	Discharge Point of Wastewater to Land Application	grab sample	Total Coliform
Annually	Hydraulic management unit	Acres used for land application	Acres
Annually	Hydraulic management unit	COD loading calculation (GS and NGS)	COD applied in lbs/acre-day
Annually	Hydraulic management unit	Report total nitrogen and phosphorus load from fertilizer or all other non-wastewater application.	Nitrogen and phosphorus applied in lbs/acre-year
Annually	Hydraulic management unit	Calculate and Report total nitrogen and phosphorus loading calculation from wastewater	Nitrogen and phosphorus applied in lbs/acre-year
Annually	Hydraulic management unit	Crop Yield Calculation and Crop Type	tons/acre, lbs/acre, or bushels/acre
Annually	Soil Monitoring unit	Composite soil sample	Electrical Conductivity, nitrate-N, ammonium-N, pH, Plant available phosphorous – (use Olsen method for soils with pH 6.5 or greater, use Bray method if soil pH is less than 6.5)
First year of permit only	Soil Monitoring unit	Composite soil sample	SAR, DTPA-FE, DTPA-Mn
Annually	Hydraulic management unit	Crop Nutrient Uptake from Crop Tissue Analysis or from standard tables for Crop Type and yield.	Nitrogen and phosphorus uptake in lbs/acre-year

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G. Monitoring Requirements

Frequency	Monitoring Point	Description and Type of Monitoring	Parameters
Annually	Hydraulic management unit	Calculate Irrigation Water Requirement for Crop Grown	Volume (inches / acre and total gallons) for each month for GS.
Annually	All flow measurement locations.	Flow measurement calibration of all flows to land application.	Document the flow measurement calibration of all flow meters and pumps used directly or indirectly measure all wastewater, tail water, flushing water, and supplemental irrigation water flows applied to each HMU.
Annually	All supplemental irrigation pumps directly connected to the wastewater distribution system.	Backflow testing	Document the testing of all backflow prevention devices for all supplemental irrigation pumps directly connected to the wastewater distribution system(s). Report the testing date(s) and results of the test (pass or fail). If any test failed, report the date of repair or replacement of backflow prevention device, and if the repaired/replaced device is operating correctly.
April of first and last permit years only.	Groundwater Monitoring Wells listed in Appendix 1.	Grab sample of groundwater (See Note 8).	Sodium, Potassium, Calcium, Magnesium, carbonate, bicarbonate.

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G. Monitoring Requirements

Frequency	Monitoring Point	Description and Type of Monitoring	Parameters
April of first and last permit years only.	Domestic and municipal wells within ¼ mile of all land application acreage.	Grab sample from domestic and municipal wells (with well owner's permission. See note 8).	Specific Conductivity, Total Dissolved Solids (TDS), Nitrite + Nitrate Nitrogen, Total Phosphorus, Chloride, Sulfate, Total Iron, Total Manganese, Sodium, Potassium, Calcium, Magnesium, carbonate, bicarbonate, Dissolved Iron[1], Dissolved Manganese[1]
Annually	Each HMU	Calculate crop nitrogen, phosphorous, and ash removal	Pounds/acre and total pounds per HMU (dry basis)
Annually	Each HMU	Calculate NGS wastewater loading rate	Million gallons & Inches/NGS
Annually	Each HMU	Calculate GS wastewater loading rate	Million gallons & Inches/GS
Twice per year (May and Oct)	Nearest Surface Water – DEQ shall review and approve locations prior to initial sampling event.	Grab samples of surface water upstream and downstream from land application site.	Nitrate + Nitrite Nitrogen, Total Phosphorous, Ortho Phosphorus, Total Dissolved Solids, Volatile Dissolved Solids, Chemical Oxygen Demand, Total Kjeldahl Nitrogen
Daily during NGS if land applying.	Meteorological data and field conditions, each HMU	Temperature, Precipitation, and field conditions.	High and low air temperatures and precipitation during each 24-hour period. Field conditions observations for areas of ponding, etc.
Note: Review permit strategy and policy for phosphorous with program office	Surface water upstream and downstream of site	For sites that apply high levels of phosphorous (for example, twice crop uptake or more) and ground water discharges to nearby surface water.	Total Phosphorous, Ortho Phosphorous, Electrical Conductivity

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G. Monitoring Requirements

1. Analytical results are required for dissolved iron and / or manganese only if the results for total iron and / or manganese exceed the standards in IDAPA 58.01.11.200.01.b.

The following are possible Monitoring Requirements that would be chosen depending on the particular permit is question. Many other options are available as the permit writer sees necessary.

1. For sites requiring groundwater monitoring, a minimum of quarterly grab samples at each of the up-gradient and down-gradient monitoring points will be required.
2. For sites requiring groundwater monitoring, twice annual (April and October) grab samples for Chloride, Nitrate-N, Nitrite-N, TDS, static water level, total iron, total manganese, and pH will be required. Note: If the MCL for total iron and manganese are exceeded, sample the well for dissolved iron and manganese. (include total coliform for systems with shallow ground water).
3. The heavy metals are not necessary unless there is a known industrial contributor. The nitrate, TDS, chloride, iron and manganese are included above.
4. For sites requiring groundwater monitoring, if the monitoring system is appropriate (as determined by staff hydrogeologist), soil sampling frequency may be reduced to the first and last years of the permit.
5. Coliform sampling frequency and other protocol for filtered systems with coliform limit of 2.2 / 100 ml.
6. If the nitrogen loading for the reporting year is 75% or less than the nitrogen permit limit, the permittee may reduce wastewater monitoring to twice per year in July and September for the following reporting year and beyond if the loading rates continues below 75%.
7. Recommendation that operators monitor TSS and BOD of both influent and effluent. This is not a requirement. However, operators can put this additional monitoring into their Operation and Maintenance Manual and use the data as an indicator of treatment performance.
8. Reduction in ground water monitoring if justified by historical data.
9. Eliminate COD wastewater monitoring requirements if historical loading rates are 5 pounds/acre-day or less.

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H. Standard Reporting Requirements

1. The permittee shall submit an Annual Wastewater-Land Application Site Performance Report ("Annual Report") prepared by a competent environmental professional no later than January 31 of each year which shall cover the previous year (see section F for WLAP reporting period). The Annual Report shall include results for monitoring required in Section G, status of compliance activities, and an interpretive discussion of monitoring data (ground water, vadose zone, hydraulic loading, wastewater etc.) with particular respect to environmental impacts by the facility.

2. The annual report shall contain the results of the required monitoring as described in Section G. Monitoring Requirements. If the permittee monitors any parameter more frequently than required by this permit, the results of this monitoring shall be included in the calculation and reporting of the data submitted in the annual report.

3. The annual report shall be submitted to the Engineering Manager in the applicable Regional DEQ Office.

Boise Regional Office
1445 N. Orchard
Boise, ID 83706-2239
208-373-550

Coeur d'Alene Regional Office
2110 Ironwood Parkway
Coeur d'Alene, ID 83814
208-769-1422

Idaho Falls Regional Office
900 N. Skyline, Suite B
Idaho Falls, ID 83402
208-528-2650

Lewiston Regional Office
1118 "F" Street
Lewiston, ID 83501
208-799-4370

Pocatello Regional Office
444 Hospital Way, #300
Pocatello, ID 83201
208-236-6160

Twin Falls Regional Office
601 Pole Line Road, Suite 2
Twin Falls, ID 83301
208-736-2190

A copy of the annual report shall also be mailed to:

Richard Huddleston, P.E.
Wastewater Program Manager
1410 N. Hilton
Boise, ID 83706
208-373-0561

4. Notice of completion of any work described in Section E. Compliance Schedule for Required Activities shall be submitted to the Department within 30 days of activity completion. The status of all other work described in Section E shall be submitted with the Annual Report.

5. All laboratory reports containing the sample results for monitoring required by Section G. Monitoring Requirements of this permit shall be submitted with the Annual Report.

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I. Standard Permit Conditions: Procedures and Reporting

1. The permittee shall at all times properly maintain and operate all structures, systems, and equipment for treatment, operational controls and monitoring, which are installed or used by the permittee to comply with all conditions of the permit or the Wastewater-Land Application Permit Regulations, in conformance with a DEQ approved, current Plan of Operations (Operations and Maintenance Manual) which describes in detail the operation, maintenance, and management of the wastewater treatment system. This Plan of Operations shall be updated as necessary to reflect current operations.

2. Wastewater(s) or recharge waters applied to the land surface must be restricted to the premises of the application site unless permission has been obtained from the DEQ authorizing a discharge into the waters of the State as stated in IDAPA 58.01.02.600.02.

3. Wastewater must not create a public health hazard or nuisance condition as stated in IDAPA 58.01.02.600.03. In order to prevent public health hazards and nuisance conditions the permittee shall:

a. Apply wastewater as evenly as practicable to the treatment area;
b. Prevent organic solids (contained in the wastewater) from accumulating on the ground surface to the point where the solids putrefy or support vectors or insects; and
c. Prevent wastewater from ponding in the fields to the point where the ponded wastewater putrefies or supports vectors or insects.

4. The permittee shall:

a. Manage the wastewater land application treatment site as an agronomic operation where vegetative cover is grown and harvested or grazed to utilize the nutrients and minerals in the wastewater, and,
b. Not hydraulically overload any particular areas of the wastewater land application treatment site.

5. All waste solids, including dredgings and sludges, shall be utilized or disposed in a manner which will prevent their entry, or the entry of contaminated drainage or leachate therefrom, into the waters of the state such that health hazards and nuisance conditions are not created; and to prevent impacts on designated beneficial uses of the ground water and surface water. The permittee's management of waste solids shall be governed by the terms of the DEQ approved Waste Solids Management Plan, which upon approval shall be an enforceable portion of this permit.

6. If the permittee intends to continue operation of the permitted facility after the expiration of an existing permit, the permittee shall apply for a new permit at least six months prior to the expiration date of the existing permit in accordance with the Waste Water Land Application Permit Regulations and include seepage tests on all lagoons per latest DEQ procedures.

7. The permittee shall allow the Director of the Idaho Department of Environmental Quality or the Director's designee (hereinafter referred to as Director), consistent with Title 39, Chapter 1, Idaho Code, to:

a. Enter the permitted facility,
b. Inspect any records that must be kept under the conditions of the permit.
c. Inspect any facility, equipment, practice, or operation permitted or required by the permit.
d. Sample or monitor for the purpose of assuring permit compliance, any substance or any parameter at the facility.

8. The permittee shall report to the Director under the circumstances and in the manner specified in this section:

a. In writing thirty (30) days before any planned physical alteration or addition to the permitted facility or activity if that alteration or addition would result in any significant change in information that was submitted during the permit application process.
b. In writing thirty (30) days before any anticipated change which would result in non-compliance with any permit condition or these regulations.
c. Orally within twenty-four (24) hours from the time the permittee became aware of any non-compliance which may endanger the public health or the environment at telephone numbers provided in the permit by the Director (see below)

DEQ Regional Office: see Permit Certification Page
Emergency 24 Hour Number 1-800-632-8000

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I. Standard Permit Conditions: Procedures and Reporting

d. In writing as soon as possible but within five (5) days of the date the permittee knows or should know of any non-compliance unless extended by the DEQ. This report shall contain:

i. A description of the non-compliance and its cause;
ii. The period of non-compliance including to the extent possible, times and dates and, if the non-compliance has not been corrected, the anticipated time it is expected to continue; and
iii. Steps taken or planned to reduce or eliminate reoccurrence of the non-compliance.

e. In writing as soon as possible after the permittee becomes aware of relevant facts not submitted or incorrect information submitted, in a permit application or any report to the Director. Those facts or the correct information shall be included as a part of this report.

9. The permittee shall take all necessary actions to prevent or eliminate any adverse impact on the public health or the environment resulting from permit noncompliance.

10. The permittee shall determine (on an on-going basis) if any noxious weed problems relate to the permitted sites. If problems are present, coordinate with the Idaho Department of Agriculture or the local County authority regarding their requirements for noxious weed control. Also address these control operations in an update to the Operations and Maintenance Manual.

J. Standard Permit Conditions: Modifications, Violations, and Revocations

1. The permittee shall furnish to the Director within reasonable time, any information including copies of records, which may be requested by the Director to determine whether cause exists for modifying, revoking, re-issuing, or terminating the permit, or to determine compliance with the permit or these regulations.
2. Both minor and major modifications may be made to this permit as stated in IDAPA 58.01.17.700.01 and 02 with respect to any conditions stated in this permit upon review and approval of the DEQ.
3. Whenever a facility expansion, production increase or process modification is anticipated which will result in a change in the character of pollutants to be discharged or which will result in a new or increased discharge that will exceed the conditions of this permit, or if it is determined by the DEQ that the terms or conditions of the permit must be modified in order to adequately protect the public health or environment, a request for either major or minor modifications must be submitted together with the reports as described in I. *Standard Reporting Requirements*, and plans and specifications for the proposed changes. No such facility expansion, production increase or process modification shall be made until plans have been reviewed and approved by the DEQ and a new permit or permit modification has been issued.
4. Permits shall be transferable to a new owner or operator provided that the permittee notifies the Director by requesting a minor modification of the permit before the date of transfer.
5. Any person violating any provision of the Waste Water Land Application Permit Regulations, or any permit or order issued thereunder shall be liable for a civil penalty not to exceed ten thousand dollars ($10,000) or one thousand dollars ($1,000) for each day of a continuing violation, whichever is greater. In addition, pursuant to Title 39, Chapter 1, Idaho Code, any willful or negligent violation may constitute a misdemeanor.
6. The Director may revoke a permit if the permittee violates any permit condition or the Wastewater Land Application Permit Regulations.
7. Except in cases of emergency, the Director shall issue a written notice of intent to revoke to the permittee prior to final revocation. Revocation shall become final within thirty-five (35) days of receipt of the notice by the permittee, unless within that time the permittee request an administrative hearing in writing to the Board of the Department of Environmental Quality pursuant to the Rules of Administrative Procedures contained in IDAPA 58.01.23.
8. If, pursuant to Idaho Code ∋ 67-5247, the Director finds the public health, safety or welfare requires emergency action, the Director shall incorporate findings in support of such action in a written notice of emergency revocation issued to the permittee. Emergency revocation shall be effective upon receipt by the permittee. Thereafter, if requested by the permittee in writing, a revocation hearing before the Board of the Department of Environmental Quality shall be provided. Such hearings shall be conducted in accordance with the Rules of Administrative Procedures contained in IDAPA 58.01.23..
9. The provisions of this permit are severable and if a provision or its application is declared invalid or unenforceable for any reason, that declaration will not affect the validity or enforceability of the remaining provisions.
10. The permittee shall notify the DEQ at least six (6) months prior to permanently removing any permitted land application facility from service, including any treatment, storage, or other facilities or equipment associated with the land application site. Prior to commencing closure activities, the permittee shall: a) participate in a pre-site closure meeting with the DEQ; b) develop a site closure plan that identifies specific closure, site characterization, or cleanup tasks with scheduled task completion dates in accordance with agreements made at the pre-site closure meeting, and c) submit the completed site closure plan to the DEQ for review and approval within forty-five (45) days of the pre-site closure meeting. The permittee must complete the DEQ approved site closure plan.

Appendix 1
Environmental Monitoring Serial Numbers

HYDRAULIC MANAGEMENT UNITS

Serial Number	Description	Acres
MU-xxxxxx		
MU-xxxxxx		
MU-xxxxxx		
MU-xxxxxx		

WASTEWATER SAMPLING POINTS

Serial Number	Description
WW-xxxxxx	
WW-xxxxxx	

SURFACE WATER SAMPLING POINTS

Serial Number	Description
SW-xxxxxx	
SW-xxxxxx	

PEIZOMETERS

Serial Number	Description
SW-xxxxxx	
SW-xxxxxx	

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Appendix 1
Environmental Monitoring Serial Numbers
SOIL MONITORING UNITS

Serial Number	Description	Associated MU
SU-xxxxxx		
SU-xxxxxx		
SU-xxxxxx		
SU-xxxxxx		

GROUND WATER MONITORING

Serial Number	Description (private, irrigation, dedicated monitoring)	Location
GW-xxxxxx		
GW-xxxxxx		
GW-xxxxxx		

LAGOONS

Serial Number	Description
LG-xxxxxx	Lagoon no. 1
LG-xxxxxx	Lagoon no. 2

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Appendix 2
Site Maps

Site Maps shall be supplied by the permittee and shall include at a minimum all requirements of IDAPA 58.01.17.300.05.e through f.

Site Map No. 1

Attach map showing general locations (property boundaries) of municipal plant and WLAP site. Include Township(s), Range(s), Section(s).

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Appendix 2
Site Maps

Site Map No. 2

Attach detailed map that shows the following:

- **All Hydraulic Management Units. Include MU serial #'s**
- **All Soil Monitoring Units. Include SU serial #'s**
- **All lagoons/storage ponds. Include serial #'s**
- **All Wastewater and Supplemental Irrigation distribution systems for the WLAP site including sumps, pipelines, ditches, irrigation diversions, irrigation systems (pivots, wheel lines, etc.), tailwater collection systems, and any other item of relevance.**

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Appendix 2
Site Maps

Site Map No. 3

Attach detailed map showing location of:

- **All monitoring wells used for permit compliance (may include domestic wells if used for groundwater monitoring compliance).**
- **All public and private drinking water supply sources within ¼ mile of WLAP site.**
- **All springs, wetlands, and surface waters within ¼ mile of WLAP site.**
- **Groundwater contours & direction of flow (include additional map(s) if flow direction changes seasonally)**

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Appendix 2
Site Maps

Site Map No. 4

Attach map showing location of:

- **All dwellings within ¼ mile of WLAP site.**
- **All public and private gathering places within ¼ mile of WLAP site**
- **All public roads within ¼ mile of WLAP site**

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A.11.3 Standard Industrial Permits

User's Guide
for the
Standard Industrial Wastewater-Land Application Permit Template

01/05/04
Introduction

The Standard Industrial Wastewater-Land Application Permit Template is a guidance document for writing industrial WLAP permits. There may be permit specific issues that are not addressed in this template or parts of the template that may not be applicable to the site you are permitting. The template serves to provide for consistent permit limits and language where appropriate.

The template includes a new section for abbreviations/acronyms and the layout has been rearranged to put permit specific information at the beginning and standard limits, requirements, and conditions towards the end of the permit.

The language that appears in yellow highlight is optional and inclusion in the permit needs to be evaluated on a case-by-case basis by the permit writer.

The Wastewater Program Office, as time permits, will update this template. If you have suggestions for modifying the template, please contact Mark Mason at (208) 373-0266.

Section E. Compliance Schedule for Required Activities

Plan of Operation – Inclusion of this compliance activity will depend on the status of the Plan of Operation at the time of permitting. If an existing facility has an adequate Plan of Operation, this is obviously not necessary. For new facilities or re-permits involving significant modifications, this requirement may be appropriate.

Nuisance Odor Management Plan – Preference would be to have the applicant submit this plan with permit application materials, especially for new systems or if there is significant public interest.

TDIS Management Plan – If ground water modeling indicates significant TDS impacts to ground water, this compliance activity should be included.

Water Quality Improvement Plan (WQIP) – For sites that have existing ground water quality that exceeds the limits in the *Ground Water Quality Rule* (IDAPA 58.01.11) for primary or secondary standards as a result of land application activities, a WQIP may be required. The WQIP requires mapping areas where ground water has been impacted. For areas where ground water quality standards are exceeded, a plan to improve ground water quality, with the objective of attaining standards is required. For areas where ground water quality is degraded, but ground water quality standards are not exceeded, best management practices or other measures described in the GWQR, section 58.01.11.400.02 shall be developed and implemented. For example language, consult with the Wastewater Program Office.
Waste Solids Management Plan – Site specific.

Buffer Zone Plan – The applicant should provide this information as part of the permit application materials. However, for new sites that are in design, this compliance activity may be required. Facilities may be developing plans for the WLAP irrigation system during the same timeframe as the draft permit

Ground Water Monitoring Plan – Site specific. Typically required for new facilities where it is determined ground water monitoring is necessary. May also be required for re-permitting sites in which the existing network is inadequate.

Section F. Permit Limits and Conditions

Supervision – Requiring supervision of the wastewater treatment system is optional. Poor past management or complex wastewater pretreatment systems prior to land application are considerations. Also helpful for simple systems where operator is not technically proficient.

Section G. Monitoring Requirements

Composite Sampling - Dependent on wastewater system. For systems with wastewater quality that is variable within a 24-hour period, the system should provide composite samples. For systems that quality does not vary significantly on a daily basis, grab samples are appropriate.

Bacterial Sampling - May be required for cheese processors, meat processors, or others in which there is documented evidence of human pathogens present. Also dependent on irrigation delivery method which may cause exposure.

Appendix 1. Environmental Monitoring Serial Numbers

Instructions for serial number assignment. Serial Numbers for monitoring points are formatted as follows. XX-xxxxxx. The upper case XX signifies the type of point (MU, WW, SW…). This is followed by a hyphen. The first four lower case x's signify the last four numbers of the permit, excluding the suffix. The last two lower case x's signify the actual point location. If the permit area expands over the life of the project, the point location numbers are just continued and expanded as necessary. No allowance is necessary for suffixes or new expansion area designation.

A. Permit Certificate

INDUSTRIAL
WASTEWATER-LAND APPLICATION PERMIT
LA-000xxx-0x

Facility Name, LOCATED AT Street address, city, ID xxxxx-xxxx AND IN **Township(s) xx, Range(s) xx, Section(s) xx IS** HEREBY AUTHORIZED TO CONSTRUCT, INSTALL, AND OPERATE A WASTEWATER-LAND APPLICATION TREATMENT SYSTEM IN ACCORDANCE WITH THE WASTEWATER-LAND APPLICATION RULES (IDAPA 58.01.17), THE WATER QUALITY STANDARDS AND WASTEWATER TREATMENT REQUIREMENTS (IDAPA 58.01.02), THE GROUND WATER QUALITY RULE (IDAPA 58.01.11), AND ACCOMPANYING PERMIT, APPENDICES, AND REFERENCE DOCUMENTS. THIS PERMIT IS EFFECTIVE FROM THE DATE OF SIGNATURE AND EXPIRES ON **(60 months from issue date)**.

Name of RO Administrator
Title i.e. (REGION) Regional Administrator
Idaho Department of Environmental Quality

Date:

DEPARTMENT OF ENVIRONMENTAL QUALITY
Regional Office Address
Regional Office Phone No.

POSTING ON SITE RECOMMENDED

B. Permit Contents, Appendices, and Reference Documents

The Sections, Appendices, and Reference Documents listed on this page are all elements of Wastewater-Land Application Permit LA-000xxx-0x and are enforceable as such. This permit does not relieve Company Name, hereafter referred to as the permittee, from responsibility for compliance with other applicable federal, state or local laws, rules, standards or ordinances.

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C. Abbreviations, Definitions

Comment: Items throughout template that are highlighted in yellow are options for considerations and additional thought as to application to a particular permit. Those items may be included, modified or deleted.

Ac-in	Acre-inch. The volume of water or wastewater to cover 1 acre of land to a depth of 1 inch. Equal to 27,154 gallons.
BMP or BMPs	Best Management Practices
COD	Chemical Oxygen Demand
DEQ or the Department	Idaho Department of Environmental Quality
Director	Director of the Idaho Department of Environmental Quality, or the Directors Designee, i.e. Regional Administrator
ET	Evapotranspiration – Loss of water from the soil and vegetation by evaporation and by plant uptake (transpiration)
GS	Growing Season – Typically April 01 through October 31 (214 days)
GW	Ground Water
GWQR	IDAPA 58.01.11 "Ground Water Quality Rule"
Handbook or Guidelines	Handbook for Land Application of Municipal and Industrial Wastewater, DEQ, April 1996.
HLRgs	Growing Season Hydraulic Loading Rate. Includes any combination of wastewater and supplemental irrigation water applied to land application hydraulic management units during the growing season. The HLRgs limit is specified in Section F. Permit Limits and Conditions.
HLRngs	Non-Growing Season Hydraulic Loading Rate. Includes any combination of wastewater and supplemental irrigation water applied to each hydraulic management unit during the non-growing season. The HLRngs limit is specified in Section F. Permit Limits and Conditions.
HMU	Hydraulic Management Unit (Serial Number designation is MU)
IWR	Irrigation Water Requirement – Any combination of wastewater and supplemental irrigation water applied at rates commensurate to the moisture requirements of the crop, and calculated monthly during the growing season (GS). Calculation methodology for the IWR can be found at the following website: http://www.kimberly.uidaho.edu/water/appndxet/index.shtml. The equation used to calculate the IWR at this website is: $IWR = (CU - P_e) / E_i$ CU is the monthly consumptive use for a given crop in a given climatic area. CU is synonymous with crop evapotranspiration P_e is the effective precipitation. CU minus Pe is synonymous with the net irrigation requirement (IR) E_i is the irrigation system efficiency. To obtain the gross irrigation water requirement (IWR), divide the IR by the irrigation system efficiency.
IDAPA	Idaho Administrative Procedures Act
LG	Lagoon
lb/ac-day	Pounds (of constituent) per acre per day
MG	Million Gallons (1 MG = 36.827 acre-inches)
MGA	Million Gallons Annually (per WLAP Reporting Year)
NGS	Non-Growing Season – Typically November 01 through March 31 (151 days)
NVDS	Non-Volatile Dissolved Solids (= Total Dissolved Solids less Volatile Dissolved Solids)
O&M manual	Operation and Maintenance Manual, also referred to as the Plan of Operation
SAR	Sodium Absorption Ratio

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C. Abbreviations, Definitions

SI	Supplemental Irrigation water applied to the land application treatment site.
Soil AWC	Soil Available Water Holding Capacity - the water storage capability of a soil to a depth at which plant roots will utilize (typically 60 inches or root limiting layer)
SMU	Soil Monitoring Unit (Serial Number designation is SU)
SW	Surface Water
TDS	Total Dissolved Solids or Total Filterable Residue
TDIS	Total Dissolved Inorganic Solids – The summation of chemical concentration results in mg/L for the following common ions: calcium, magnesium, potassium, sodium, chloride, sulfate, and 0.6 times alkalinity (alkalinity expressed as calcium carbonate). Nitrate, Silica and fluoride shall be included if present in significant quantities (i.e. > 5 mg/L each).
TMDL	Total Maximum Daily Load – The sum of the individual waste-load allocations (WLA's) for point sources, Load Allocations (LA's) for non-point sources, and natural background. Such load shall be established at a level necessary to implement the applicable water quality standards with seasonal variations and a margin of safety that takes into account any lack of knowledge concerning the relationship between effluent limitations and water quality. IDAPA 58.01.02 *Water Quality Standards and Wastewater Treatment Requirements*
Typical Crop Uptake	Typical Crop Uptake is defined as the median constituent crop uptake from the three (3) most recent years the crop has been grown. Typical Crop Uptake is determined for each hydraulic management unit. For new crops having less than three years of on-site crop uptake data, regional crop yield data and typical nutrient content values, or other values approved by DEQ may be used.
USGS	United States Geological Survey
WLAP	Wastewater Land Application Permit (or Program)
WLAP Reporting Year	The reporting year begins with the non-growing season and extends through the growing season of the following year, typically November 01 – October 31. For example, the 2000 Reporting Year was November 01, 1999 through October 31, 2000.
WW	Wastewater applied to the land application treatment site

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D. Facility Information

Legal Name of Permittee	
Type of Wastewater	
Method of Treatment	
Type of Facility	
Facility Location	
Legal Location	
County	
USGS Quad	
Soils on Site	
Depth to Ground Water	
Beneficial Uses of Ground Water	
Nearest Surface Water	
Beneficial Uses of Surface Water	
Responsible Official Mailing Address **Phone / Fax**	
Facility Consultants Mailing Address **Phone / Fax**	

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E. Compliance Schedule for Required Activities

Optional items to be edited are highlighted in yellow.

The Activities in the following table shall be completed on or before the Completion Date unless modified by the Department in writing.

Compliance Activity Number Completion Date	Compliance Activity Description
CA-xxx-xx **Prior to applying wastewater at site**	A Plan of Operation (Operation and Maintenance Manual or O&M Manual) for the wastewater land application facilities, incorporating the requirements of this permit, shall be submitted to DEQ for review and comment. The O&M manual shall be designed for use as an operator guide for actual day-to-day operations to meet permit requirements and shall include daily sampling and monitoring requirements to insure proper operation of the wastewater treatment facility. The Plan of Operation shall contain at a minimum all of the information required by the latest revision of the Plan of Operation Checklist in the WLAP Program Guidance. Upon approval, the manual shall be incorporated by reference into this permit and shall be enforceable as a part of this permit.
CA-xxx-xx **Prior to applying wastewater at site**	Submit a Nuisance Odor Management Plan to DEQ for review and approval. The Odor Management Plan shall include wastewater treatment systems, land application facilities, and other operations associated with the facility. The plan shall include specific design considerations, operation and maintenance procedures, and management practices to be employed to minimize the potential for or limit odors. The plan shall also include procedures to respond to an odor incident if one occurs, including notification procedures.
CA-xxx-xx **Prior to applying wastewater at site**	A TDIS Management Plan may be required if ground water TDS significantly increases across the site. The plan shall identify sources of TDIS, evaluate the feasibility of isolation or removal of TDIS, and propose strategies to minimize TDIS in the wastewater.
CA-xxx-xx **Prior to applying wastewater at site**	For sites that have existing ground water quality that exceeds standards as a result of land application activities, a Water Quality Improvement Plan (WQIP) may be required.
CA-xxx-xx **Prior to applying wastewater at site**	Submit to the Department for review and approval, a well location acceptability analysis, as outlined in the *Handbook for Land Application of Municipal and Industrial Wastewater, April 1996*, pages IV-19 through IV-23 for all applicable wells located around or on the land application site.
CA-xxx-xx **Prior to application of waste solids**	Submit a Waste Solids Management Plan to DEQ for review and approval. The Plan shall describe how waste solids generated at the facility will be handled and disposed of to meet the requirements of section J, No. 5.

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E. Compliance Schedule for Required Activities

Compliance Activity Number Completion Date	Compliance Activity Description
CA-xxx-xx Prior to applying wastewater at site	Submit a scaled site map delineating buffer zones, homes, public access areas, private wells, canals, etc. and the actual area in acres of each HMU. Site Maps shall be supplied by the permittee and shall include at a minimum all requirements of IDAPA 58.01.17.300.05.e through f.
CA-xxx-xx Prior to applying wastewater at site	Submit plans and specifications for ground water monitoring network for DEQ review and approval, including at least one (1) upgradient well and two (2) downgradient wells.

(Add other optional requirements for grazing plans, seepage testing, and silviculture here in compliance activities to further describe particular requirements for each site.)

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F. Permit Limits and Conditions

Category	Permit Limits and Conditions
Type of Wastewater	
Application Site Area	
Application Season	
Growing Season (GS)	Site specific – see definitions, abbreviations
Non-growing Season (NGS)	Site specific – see definitions, abbreviations
Supervision	Optional (Certified Operator)
Reporting Year for Annual Loading Rates	Site Specific Dates Comment: It should always be consecutive NGS & GS periods
Growing Season Maximum Hydraulic Loading Rate (Applies to wastewater and supplemental irrigation water).	Growing Season (GS) Hydraulic Loading Rate shall be no greater than the Irrigation Water Requirement (IWR) using data from the tables of the following University Of Idaho web site: http://www.kimberly.uidaho.edu/water/appndxet/index.shtml. IWR is equal to the Mean IR data from these tables divided by the irrigation system efficiency. In lieu of these tables, current climatic and evaporation data, or 30-year average data may be used to calculate the IWR, as defined in the 1994 Technical Interpretive Supplement, pages IV-6 and IV-7. Assume no carryover soil moisture and a leaching rate of zero in calculating the IWR. Application shall generally follow consumptive use rates for the crop throughout the season.
Non-Growing Season Maximum Hydraulic Loading Rate	Soil AWC – Precipitation $_{NGS}$ + Evapotranspiration $_{NGS}$ for each hydraulic management unit (HMU). Include the allowable amount in inches and MG for each HMU in this section based on this equation. HMU # Field Description Million Gallons Inches 1 Pivots 1 and 2 x.xx x.xx 2 Pivot 3 x.xx x.xx etc.…
No Runoff	______ shall prepare and submit to DEQ for approval a runoff management plan with control structures and other BMPs (e.g. collection basins, berms, etc.) designed to prevent runoff from any site or fields used for wastewater land application to property not owned by ______ except in the event of a 25-year, 24-hour storm event or greater, using Western Regional Climate Center (WRCC) Precipitation Frequency Map, Figure 28 'Isopluvials of 25-YR, 24-HR Precipitation'. For this site, the 25-year, 24-hour event is ___ inches. Upon approval of the plan by DEQ, ______ shall implement the

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F. Permit Limits and Conditions

Category	Permit Limits and Conditions
	runoff management plan, and shall construct, operate, and maintain the control structures and other BMPs in accordance with the plan.
Livestock Grazing	A grazing management plan shall be submitted to DEQ for review and approval prior to any grazing activities. Grazing Plans shall follow the guidance located on the DEQ Internet site.
Ground Water Quality	Ground water quality shall be in compliance with the Ground Water Quality Rule (GWQR), IDAPA 58.01.11.
Maximum COD Loading, seasonal average in Pounds/acre-day, each HMU	50 pounds / acre-day seasonal average for growing season. 25 pounds / acre-day seasonal average for the non-growing season.
Maximum Nitrogen Loading Rate, pounds/acre-year, each HMU (from all sources including waste solids and supplemental fertilizers)	150% of typical crop uptake (see definition) or UI Fertility Guide.
Maximum Phosphorus Loading Rate, pounds/acre-year (from all sources including waste solids and supplemental fertilizers)	None. DEQ reserves the right to re-open this permit for inclusion of phosphorous limits.
Construction Plans	Prior to construction or modification of all wastewater facilities associated with the land application system or expansion, detailed plans and specifications shall be reviewed and approved by DEQ. Within 30 days of completion of construction, the permittee shall submit as-built plans for review and approval.
Buffer Zones and Wellhead Protection	Buffer zones of 500 feet or more shall be maintained between land application areas and domestic water supplies (or 1000 feet for public water supplies) unless a Department approved well location acceptability analysis indicates an alternative buffer zone is acceptable (see Idaho WLAP Handbook for discussion on approved well location acceptability analysis). **(Consult with the regional office to see if a source water assessment has been completed for the area. Consult local ordinances for more strict requirements.)**

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F. Permit Limits and Conditions

Category	Permit Limits and Conditions
	Berms and other BMPs shall be used to protect the well head of on-site wells.
Industrial Wastewater Buffer Zones	All buffer zones must comply with, at a minimum, local zoning ordinances. See Table 4 – Industrial Buffer Zone Scenarios, in Section IV (1994 Technical Supplement) of the Idaho Handbook for Land Application of Municipal and Industrial Wastewater.
Supplemental Irrigation Water Protection	For systems with wastewater and fresh irrigation water interconnections, DEQ-approved backflow prevention devices are required.
Odor Management	The wastewater treatment plant, land application facilities, and other operations associated with the facility shall not create a public health hazard or nuisance conditions including odors. These facilities shall be managed in accordance with a DEQ approved Odor Management Plan.
Fencing and Posting	See WLAP Guidance.
Allowable Crops	Crops grown for direct human consumption (those crops that are not processed prior to consumption) are not allowed.

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G. Monitoring Requirements

The Permittee is allowed to apply wastewater and treat it on a land application site as prescribed in the table below and in accordance with all other applicable permit conditions and schedules.

1) Appropriate analytical methods, as given in the *Handbook for Land Application of Municipal and Industrial Wastewater, April 1996*, or as approved by the Idaho Department of Environmental Quality (hereinafter referred to as DEQ), shall be employed. A description of approved sample collection methods, appropriate analytical methods and companion QA/QC protocol shall be included in the Operation and Maintenance Manual.

2) The permittee shall monitor and measure parameters as stated in the Facility Monitoring Table in this section.

3) Samples shall be collected at times and locations that represent typical environmental and process parameters being monitored.

4) Unless otherwise agreed to in writing by the DEQ, data collected and submitted shall include, but not be limited to, the parameters and frequencies in the Facility Monitoring Table on the following pages. Monitoring is required at the frequency show in the table below if wastewater is applied anytime during the time period shown.

5) Ten (10) soil sample locations shall be selected for each management unit with greater than fifteen acres and Five (5) soil sample locations shall be selected for each management unit with fifteen acres or less. Three (3) soil samples shall be collected at each sample location, one at 0-12 inches, one at 12-24 inches, and one at 24-36 inches. The soil samples collected at each depth shall be composited to yield three (3) samples for analysis from each management unit.

6) Ground Water Monitoring Procedure: Ground Water Monitoring Wells shall be purged a minimum of three casing volumes and/or until field measurements for pH, specific conductance and temperature meet the following conditions: two successive temperature values measured at least five minutes apart are within one degree Celsius of each other, pH values for two successive measurements measured at least five minutes apart are within 0.2 units of each other, and two successive specific conductance values measured at least five minutes apart are within 10% of each other. This procedure will determine when the wells are suitable for sampling for constituents required by the permit. Other procedures, such as low flow sampling, may be considered by DEQ for approval. The static water level shall be measured prior to pumping or sampling for ground water.

7) Surface water sampling guidance: DEQ to review and approve methods, timing and locations for sampling prior to initial sampling event.

8) Annual reporting of monitoring requirements is described in Section H, Standard Reporting Requirements.

9) Monitoring locations are defined in Appendix 1, "Environmental Monitoring Serial Numbers".

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G. Monitoring Requirements

Facility Monitoring Table

Frequency	Monitoring Point	Description/Type of Monitoring	Parameters
Daily	Flow meter	Flow of wastewater into land application system	Volume (million gallons and acre-inches) to each hydraulic management unit (HMU), record monthly and annually
Monthly	Effluent to land application	Wastewater quality into land application system – 24-hr. Composite	Chemical Oxygen Demand, Total Kjeldahl Nitrogen, Ammonia-Nitrogen, Nitrite + Nitrate-Nitrogen, Total Phosphorous, Chloride, Electrical Conductivity, Potassium, pH
Quarterly	Effluent to land application	Wastewater quality into land application system	Total Dissolved Inorganic Solids (TDIS) – See Table B-1. Submit analysis of individual ions in addition to TDIS.
Quarterly (for the first year only, 4 sample events)	Effluent to land application	Wastewater quality into land application system – 24-hr. composite.	Total Dissolved Solids (TDS), Volatile Dissolved Solids (VDS)
Quarterly (for the first year only, 4 sample events)	Effluent to land application	Grab sample for bacteria	Colony numbers for Fecal Coliform, Total Coliform, Fecal Streptococcus and Pseudomonas, standard presence / absence test for Listeria (if present, determine specific type)
Daily	Flow meter or Calibrated Pump Rate	Supplemental Irrigation Water	Volume (million gallons and acre-inches) to each HMU, report monthly and annually.
Twice per year (May and Oct)	Supplemental Irrigation at diversions	Grab sample	Nitrate + Nitrite Nitrogen, Total Phosphorous, Ortho Phosphorus, Total Dissolved Solids, Volatile Dissolved Solids, Chloride, Total Kjeldahl Nitrogen
Quarterly (Feb, May, Aug, and Nov)	Ground Water monitoring wells, listed in appendix 1	See Note 6	Nitrate-Nitrogen, Total Phosphorous, Total Dissolved Solids, water table elevation, water table depth, total iron, total manganese, chloride, dissolved iron[1], dissolved manganese[1], pH, conductivity, and temperature.

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G. Monitoring Requirements

Frequency	Monitoring Point	Description/Type of Monitoring	Parameters
Twice per year (May and Oct)	Nearest Surface Water – DEQ shall review and approve locations prior to initial sampling event.	Grab samples of surface water upstream and downstream from land application site.	Nitrate + Nitrite Nitrogen, Total Phosphorous, Ortho Phosphorus, Total Dissolved Solids, Volatile Dissolved Solids, Chemical Oxygen Demand, Total Kjeldahl Nitrogen
Monthly	Each HMU	Calculate IWR for each crop type	Volume (million gallons and acre-inches) to each HMU, record monthly
Daily during NGS (if land applying)	Meteorological data and field conditions, each HMU	Temperature, Precipitation, and field conditions.	High and low air temperatures and precipitation during each 24-hour period. Field conditions observations for areas of ponding, etc.)
Note: Review permit strategy for phosphorous with program office	Surface water upstream and downstream of site	For sites that apply high levels of phosphorous (for example, twice crop uptake or more) and ground water discharges to nearby surface water	Total Phosphorous, Ortho Phosphorous, Electrical Conductivity
Twice per year (April and Nov)	Each soil monitoring unit	See note 5	Electrical Conductivity, Nitrate-Nitrogen, Ammonium Nitrogen, Plant Available Phosphorus, pH, % organic matter, potassium, DTPA Fe and Mn. Notes: Add SAR if sodium loading rates are high Phosphorous – use Olsen method for soils with pH 6.5 or higher. Use Bray method if soil pH is <6.5
Annually	Each HMU	Crop type and yield	Pounds/acre and total pounds per HMU (specify moisture basis)
	Each HMU	Plant tissue analysis: Composite sample of harvested portion	Nitrate-nitrogen, Total Kjeldahl Nitrogen, Total Phosphorus, ash (dry basis)
	Each HMU	Calculate crop nitrogen, phosphorous, and ash removal	Pounds/acre and total pounds per HMU (dry basis)
	Each HMU	Calculate NGS wastewater loading rate	Million gallons & Inches/NGS

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G. Monitoring Requirements

Frequency	Monitoring Point	Description/Type of Monitoring	Parameters
	Each HMU	Calculate GS wastewater loading rate	Million gallons & Inches/GS
	Each HMU	Calculate seasonal average COD loading rate (GS and NGS)	Pounds/acre-day
	Each HMU	Calculate wastewater nitrogen loading rate	Pounds/acre-year
	Each HMU	Calculate wastewater phosphorous loading rate	Pounds/acre-year
	Each HMU	Calculate wastewater TDIS loading rate	Pounds/acre-year
	Each HMU	Report nitrogen and phosphorous fertilizer application rates	Type and Pounds/acre-year
Annually	Each HMU	Calculate Inorganic TDS loading (NVDS) from supplemental irrigation application.	NVDS applied in lbs/ac-yr
Annually	All flow measurement locations.	Flow measurement calibration of all flows to land application.	Document the flow measurement calibration of all flow meters and pumps used directly or indirectly measure all wastewater, tail water, flushing water, and supplemental irrigation water flows applied to each HMU.
Annually	All supplemental irrigation pumps directly connected to the wastewater distribution system.	Backflow testing	Document the testing of all backflow prevention devices for all supplemental irrigation pumps directly connected to the wastewater distribution system(s). Report the testing date(s) and results of the test (pass or fail). If any test failed, report the date of repair or replacement of backflow prevention device, and if the repaired/replaced device is operating correctly.

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G. Monitoring Requirements

Frequency	Monitoring Point	Description/Type of Monitoring	Parameters
April of first and last permit years only.	Groundwater Monitoring Wells listed in Appendix 1.	Grab sample of groundwater (See Note 6).	Sodium, Potassium, Calcium, Magnesium, carbonate, bicarbonate.
April of first and last permit years only.	Domestic and municipal wells within ¼ mile of all land application acreage.	Grab sample from domestic and municipal wells (with well owner's permission. See note 6).	Specific Conductivity, Total Dissolved Solids (TDS), Nitrite + Nitrate Nitrogen, Total Phosphorus, Chloride, Sulfate, Total Iron, Total Manganese, Sodium, Potassium, Calcium, Magnesium, carbonate, bicarbonate, Dissolved Iron[1], Dissolved Manganese[1]

1. Analytical results are required for dissolved iron and/or manganese only if the results for total iron and/or manganese exceed the standards in IDAPA 58.01.11.200.01.b.

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H. Standard Reporting Requirements

1.) The Permittee shall submit an Annual Wastewater-Land Application Site Performance Report ("Annual Report") prepared by a competent environmental professional no later than January 31 of each year, which shall cover the previous reporting year. The Annual Report shall include an interpretive discussion of monitoring data (ground water, soils, hydraulic loading, wastewater etc.) with particular respect to environmental impacts by the facility.

2.) The annual report shall contain the results of the required monitoring as described in *Section G. Monitoring Requirements*. If the permittee monitors any parameter more frequently than required by this permit, the results of this monitoring shall be included in the calculation and reporting of the data submitted in the annual report.

3.) The annual report shall be submitted to the Engineering Manager in the applicable Regional DEQ Office.

Boise Regional Office
1445 N. Orchard
Boise, ID 83706-2239
208-373-550

Coeur d'Alene Regional Office
2110 Ironwood Parkway
Coeur d'Alene, ID 83814
208-769-1422

Idaho Falls Regional Office
900 N. Skyline, Suite B
Idaho Falls, ID 83402
208-528-2650

Lewiston Regional Office
1118 "F" Street
Lewiston, ID 83501
208-799-4370

Pocatello Regional Office
444 Hospital Way, #300
Pocatello, ID 83201
208-236-6160

Twin Falls Regional Office
601 Pole Line Road, Suite 2
Twin Falls, ID 83301
208-736-2190

A copy of the annual report shall also be mailed to:

Richard Huddleston, P.E.
Wastewater Program Manager
1410 N. Hilton
Boise, ID 83706
208-373-0561

4.) Notice of completion of any work described in *Section E. Compliance Schedule for Required Activities* shall be submitted to the Department within 30 days of activity completion. The status of all other work described in Section E shall be submitted with the Annual Report.

5.) All laboratory reports containing the sample results for monitoring required by *Section G. Monitoring Requirements* of this permit shall be submitted with the Annual Report.

I. Standard Permit Conditions: Procedures and Reporting

1. The permittee shall at all times properly maintain and operate all structures, systems, and equipment for treatment, operational controls and monitoring, which are installed or used by the permittee to comply with all conditions of the permit or the Wastewater-Land Application Permit Regulations, in conformance with a DEQ approved, current Plan of Operations (Operations and Maintenance Manual) which describes in detail the operation, maintenance, and management of the wastewater treatment system. This Plan of Operations shall be updated as necessary to reflect current operations.

2. Wastewater(s) or recharge waters applied to the land surface must be restricted to the premises of the application site unless permission has been obtained from the DEQ authorizing a discharge into the waters of the State as stated in IDAPA 58.01.02.600.02.

3. Wastewater must not create a public health hazard or nuisance condition as stated in IDAPA 58.01.02.600.03. In order to prevent public health hazards and nuisance conditions the permittee shall:

   a. Apply wastewater as evenly as practicable to the treatment area;
   b. Prevent organic solids (contained in the wastewater) from accumulating on the ground surface to the point where the solids putrefy or support vectors or insects; and
   c. Prevent wastewater from ponding in the fields to the point where the ponded wastewater putrefies or supports vectors or insects.

4. The permittee shall:

   a. Manage the wastewater land application treatment site as an agronomic operation where vegetative cover is grown and harvested or grazed to utilize the nutrients and minerals in the wastewater, and,
   b. Not hydraulically overload any particular areas of the wastewater land application treatment site.

5. All waste solids, including dredgings and sludges, shall be utilized or disposed in a manner which will prevent their entry, or the entry of contaminated drainage or leachate therefrom, into the waters of the state such that health hazards and nuisance conditions are not created; and to prevent impacts on designated beneficial uses of the ground water and surface water. The permittee's management of waste solids shall be governed by the terms of the DEQ approved Waste Solids Management Plan, which upon approval shall be an enforceable portion of this permit.

6. If the permittee intends to continue operation of the permitted facility after the expiration of an existing permit, the permittee shall apply for a new permit at least six months prior to the expiration date of the existing permit in accordance with the Waste Water Land Application Permit Regulations and include seepage tests on all lagoons per latest DEQ procedures.

7. The permittee shall allow the Director of the Idaho Department of Environmental Quality or the Director's designee (hereinafter referred to as Director), consistent with Title 39, Chapter 1, Idaho Code, to:

   a. Enter the permitted facility,
   b. Inspect any records that must be kept under the conditions of the permit.
   c. Inspect any facility, equipment, practice, or operation permitted or required by the permit.
   d. Sample or monitor for the purpose of assuring permit compliance, any substance or any parameter at the facility.

8. The permittee shall report to the Director under the circumstances and in the manner specified in this section:

   a. In writing thirty (30) days before any planned physical alteration or addition to the permitted facility or activity if that alteration or addition would result in any significant change in information that was submitted during the permit application process.
   b. In writing thirty (30) days before any anticipated change which would result in non-compliance with any permit condition or these regulations.
   c. Orally within twenty-four (24) hours from the time the permittee became aware of any non-compliance which may endanger the public health or the environment at telephone numbers provided in the permit by the Director (see below)

LA-000xxx-0x	**Company Name**	**Date**	**Page 19**

I. Standard Permit Conditions: Procedures and Reporting

DEQ Regional Office: see Permit Certificate Page
Emergency 24 Hour Number: 1-800-632-8000

d. In writing as soon as possible but within five (5) days of the date the permittee knows or should know of any non-compliance unless extended by the DEQ. This report shall contain:

   i. A description of the non-compliance and its cause;
   ii. The period of non-compliance including to the extent possible, times and dates and, if the non-compliance has not been corrected, the anticipated time it is expected to continue; and
   iii. Steps taken or planned to reduce or eliminate reoccurrence of the non-compliance.

e. In writing as soon as possible after the permittee becomes aware of relevant facts not submitted or incorrect information submitted, in a permit application or any report to the Director. Those facts or the correct information shall be included as a part of this report.

9. The permittee shall take all necessary actions to prevent or eliminate any adverse impact on the public health or the environment resulting from permit noncompliance.

10. The permittee shall determine (on an on-going basis) if any noxious weed problems relate to the permitted sites. If problems are present, coordinate with the Idaho Department of Agriculture or the local County authority regarding their requirements for noxious weed control. Also address these control operations in an update to the Operations and Maintenance Manual.

J. Standard Permit Conditions: Modifications, Violation, and Revocation

1. The permittee shall furnish to the Director within reasonable time, any information including copies of records, which may be requested by the Director to determine whether cause exists for modifying, revoking, re-issuing, or terminating the permit, or to determine compliance with the permit or these regulations.

2. Both minor and major modifications may be made to this permit as stated in IDAPA 58.01.17.700.01 and 02 with respect to any conditions stated in this permit upon review and approval of the DEQ.

3. Whenever a facility expansion, production increase or process modification is anticipated which will result in a change in the character of pollutants to be discharged or which will result in a new or increased discharge that will exceed the conditions of this permit, or if it is determined by the DEQ that the terms or conditions of the permit must be modified in order to adequately protect the public health or environment, a request for either major or minor modifications must be submitted together with the reports as described in Section L *Standard Reporting Requirements*, and plans and specifications for the proposed changes. No such facility expansion, production increase or process modification shall be made until plans have been reviewed and approved by the DEQ and a new permit or permit modification has been issued.

4. Permits shall be transferable to a new owner or operator provided that the permittee notifies the Director by requesting a minor modification of the permit before the date of transfer.

5. Any person violating any provision of the Wastewater Land Application Permit Regulations, or any permit or order issued thereunder shall be liable for a civil penalty not to exceed ten thousand dollars ($10,000) or one thousand dollars ($1,000) for each day of a continuing violation, whichever is greater. In addition, pursuant to Title 39, Chapter 1, Idaho Code, any willful or negligent violation may constitute a misdemeanor.

6. The Director may revoke a permit if the permittee violates any permit condition or the Wastewater Land Application Permit Regulations.

7. Except in cases of emergency, the Director shall issue a written notice of intent to revoke to the permittee prior to final revocation. Revocation shall become final within thirty-five (35) days of receipt of the notice by the permittee, unless within that time the permittee request an administrative hearing in writing to the Board of Environmental Quality pursuant to the Rules of Administrative Procedures contained in IDAPA 58.01.23.

8. If, pursuant to Idaho Code 67-5247, the Director finds the public health, safety or welfare requires emergency action, the Director shall incorporate findings in support of such action in a written notice of emergency revocation issued to the permittee. Emergency revocation shall be effective upon receipt by the permittee. Thereafter, if requested by the permittee in writing, a revocation hearing before the Board of Environmental Quality shall be provided. Such hearings shall be conducted in accordance with the Rules of Administrative Procedures contained in IDAPA 58.01.23.

9. The provisions of this permit are severable and if a provision or its application is declared invalid or unenforceable for any reason, that declaration will not affect the validity or enforceability of the remaining provisions.

10. The permittee shall notify the DEQ at least six (6) months prior to permanently removing any permitted land application facility from service, including any treatment, storage, or other facilities or equipment associated with the land application site. Prior to commencing closure activities, the permittee shall: a) participate in a pre-site closure meeting with the DEQ; b) develop a site closure plan that identifies specific closure, site characterization, or cleanup tasks with scheduled task completion dates in accordance with agreements made at the pre-site closure meeting; and c) submit the completed site closure plan to the DEQ for review and approval within forty-five (45) days of the pre-site closure meeting. The permittee must complete the DEQ approved site closure plan.

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Appendix 1
Environmental Monitoring Serial Numbers

HYDRAULIC MANAGEMENT UNITS

Serial Number	**Description**	**Acres**
MU-xxxxxx		
MU-xxxxxx		
MU-xxxxxx		
MU-xxxxxx		

WASTEWATER SAMPLING POINTS

Serial Number	**Description**
WW-xxxxxx	
WW-xxxxxx	

SURFACE WATER SAMPLING POINTS

Serial Number	**Description**
SW-xxxxxx	
SW-xxxxxx	

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Appendix 1
Environmental Monitoring Serial Numbers

SOIL MONITORING UNITS

Serial Number	**Description**	**Associated MU**
SU-xxxxxx		
SU-xxxxxx		
SU-xxxxxx		
SU-xxxxxx		

GROUND WATER MONITORING

Serial Number	**Description** (private, irrigation, dedicated monitoring)	**Location**
GW-xxxxxx		
GW-xxxxxx		
GW-xxxxxx		

LAGOONS

Serial Number	**Description**
LG-xxxxxx	Lagoon no. 1
LG-xxxxxx	Lagoon no. 2

LA-000xxx-0x	**Company Name**	**Date**	**Page 23**

Appendix 2
Site Maps

Site Maps shall be supplied by the permittee and shall include at a minimum all requirements of IDAPA 58.01.17.300.05.e through f.

Site Map No. 1

Attach map showing general locations (property boundaries) of industrial plant and WLAP site. Include Township(s), Range(s), Section(s).

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Appendix 2
Site Maps

Site Map No. 2

Attach detailed map that shows the following:

- **All Hydraulic Management Units. Include MU serial #'s**
- **All Soil Monitoring Units. Include SU serial #'s**
- **All lagoons/storage ponds. Include serial #'s**
- **All Wastewater and Supplemental Irrigation distribution systems for the WLAP site including sumps, pipelines, ditches, irrigation diversions, irrigation systems (pivots, wheel lines, etc.), tailwater collection systems, and any other item of relevance.**

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Appendix 2
Site Maps

Site Map No. 3

Attach detailed map showing location of:

- **All monitoring wells used for permit compliance (may include domestic wells if used for groundwater monitoring compliance).**
- **All public and private drinking water supply sources within ¼ mile of WLAP site.**
- **All springs, wetlands, and surface waters within ¼ mile of WLAP site.**
- **Groundwater contours & direction of flow (include additional map(s) if flow direction changes seasonally)**

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Appendix 2
Site Maps

Site Map No. 4

Attach map showing location of:

- **All dwellings within ¼ mile of WLAP site.**
- **All public and private gathering places within ¼ mile of WLAP site**
- **All public roads within ¼ mile of WLAP site**

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A.12 Program Forms and Spreadsheets

Please contact DEQ, Permits and Enforcement, in Boise at 208-373-0502 or in Coeur d'Alene at 208-769-1422 for any questions or clarification of the application materials.

Application for Wastewater Reuse Permit

Instructions: Complete the following form and attachments as completely as possible. Failure to provide sufficient information will delay processing of the application and final action on the permit. A pre-application meeting between the applicant and DEQ is strongly encouraged to discuss site specific issues and level of detail needed. If clarification is needed, contact the DEQ office in your Region.

Type of application (attach appropriate checklists) New ☐ Renewal ☐ Waiver ☐ Major Modification ☐ Minor Modification ☐	For DEQ use only

Legal Name of Applicant

Address

Facility Address, if different

	Responsible Official	Alternate Official
Name		
Title		
Address		
Phone/Fax		

Attachments (complete all that apply)

- ☐ Facility Information
- ☐ List of local, state, federal permits, licenses, and approvals related to activity which have been applied for and which have been received and the dates of application or approval. Include planning & zoning or conditional use permit.
- ☐ Copy of lease, rental agreement, or ownership documentation.
- ☐ Preliminary Technical Report and Checklist: including climatic, hydrogeologic, soils, wastewater quantity and quality, site characteristics, buffer distances, and general description of application methods.
- ☐ Plan of Operation and Checklist: including operation, maintenance, and management of land application systems. If new, submit draft outline of plan of operation; if existing, submit detailed plan of operation.

The information contained in this application and attached documents is true and correct to the best of my knowledge and belief.

Signature of Owner or
legally authorized Representative ______________________________

Title Date

Facility Information

Type of Waste	__Municipal/Domestic __Cheese Processing __Potato Processing __Sugar Beet Processing __ Industrial Processing __ Other _________
Method of Treatment	__Rapid Infiltration ___Slow Rate __Overland Flow
Type of Facility	__Public __ Private __ Federal
Amount of wastewater land applied	_____________ Million Gallons Annually
Site Elevation	_____________ Feet
Legal Location (Township, Range, Section)	__Township __ Range __ Section
County	
USGS Quadrangle	
Representative soil profile (textures and depths to 60 inches)	
Seasonal High Ground Water	__Depth to seasonal high ground water __Season encountered
Depth to Aquifer	__Depth to first water __Depth to regional aquifer
Beneficial Uses of Ground Water	__Agriculture __Industrial __Domestic __Aquaculture
Nearest surface water and distance	
Beneficial uses of surface water	___Agriculture __Industrial __Domestic __Recreation ___Aquatic Life
Engineer/Consultant Name/Address Phone/Fax	
Engineer/Consultant Name/Address Phone/Fax	

Wastewater Reuse
Plan of Operation Checklist

For new facilities, a general outline of the plan of operation must be provided with the permit application. A detailed plan of operation must be provided at the 50% completion point of construction. In addition, after one (1) year of operation, the plan must be updated to reflect actual operating procedures. The checklist should be used as a guide in preparing the plan of operation. Include the completed checklist with your plan of operation. A pre-application meeting between the applicant and DEQ is strongly encouraged. If any item needs clarification, contact the DEQ Office in your Region.

YES	NA	**Plan of Operation Checklist**
		Operation & Management Responsibility a. Operator, manager responsibility
		b. Training requirements
		c. List of reference publications
		Permits and Standards a. WLAP/NPDES permit included
		b. Permit requirements listed
		c. Treatment requirements
		General Plant Description a. Type of treatment described
		b. Principal design criteria
		c. Flow diagram
		d. Hydraulic profile
		e. Characterization of Wastewater
		h. List of unit operations
		i. Overall plant efficiency
		Description, Operation and Control of Unit Operations a. Description of process
		c. Normal operation or control of process (valve position, flow rate, sludge depth, etc)
		d. List major components & mechanical equipment
		f. Schematic diagram of each unit

YES	NA	**Plan of Operation Checklist**
		h. Discussion of common operating problems
		i. Emergency operation or alternate operation
		k. Discuss laboratory tests for unit control
		l. Discuss startup procedures
		m. Brief operation instructions for each piece of equipment w/reference to manufacturers O&M Manual
		Land Application Site a. Map of the current hydraulic management units and associated acres
		b. Description of any proposed changes to the land application acreage.
		c. Map of type(s) of irrigation system(s) (pivot, hand lines,…) and the corresponding irrigation efficiency(ies).
		Wastewater Characterization a. Identification of the quantity of land applied wastewater (per day, per month, per year) and how the quantity values were determined.
		b. Characterization of the concentrations of key constituents in the wastewater proposed for land application and how the concentration values were determined. *Basic constituents of interest are: total nitrogen, total phosphorus, and Chemical Oxygen Demand (COD). Depending on the wastewater source, concentrations of other constituents may be important. For industrial systems, concentrations of total dissolved inorganic solids (TDIS) and/or metals may be pertinent. For municipal systems, total coliform counts may be presented.*
		Cropping Plan a. Description of proposed crop selection and a 5-year rotation plan. For each crop, description of: planting and harvesting data, irrigation sensitivity, rooting depth, expected yield (compared to yield data published by Idaho county, and expected crop uptake values for key constituents in the wastewater.
		b. For each crop, calculated the Irrigation Water Requirement (IWR) and how the IWR value(s) were determined.
		c. If proposing to utilize wastewater for tree irrigation, a silvicultural plan (a plan covering the care and cultivation of the trees).
		d. Description of the proposed future use of fertilizers at the site and nutrient loading associated with fertilizer use.
		Hydraulic Loading Rate a. Wastewater hydraulic loading rates by month for growing season and non-growing season.
		b. Description of the availability of supplemental irrigation water for the site and whether or not supplemental irrigation water is expected to be used at the site.

YES	NA	Plan of Operation Checklist
		Documentation that water rights exist to provide supplemental irrigation. If expected to be used, the typical supplemental irrigation water hydraulic loading rates for potential crops.
		c. Description of irrigation scheduling for the site.
		d. If storage of wastewater is proposed, a monthly water balance for the storage structure(s) reflecting: number of days of storage, required freeboard, minimum depth, evaporation, precipitation, and flows into and out of the structure.
		Constituent Loading Rates a. The expected growing season and non-growing season loading rates for key constituents including any waste solids and/or fertilizers proposed to be applied to the land application site.
		b. Comparison of expected constituent loading rates to applicable crop uptake values for the site.
		c. Identification of the design limiting constituent.
		Compliance Activities a. A summary and status of and compliance activities.
		Seepage Rate Testing a. Schedule and procedure for seepage rate testing of any wastewater lagoons.
		Site Management Plan a. Buffer Zone Plan including map of land application site that includes the following buffer objects: dwellings, areas of public access, canals/ditches, private water sources, and public water sources. Map to include signage and fencing and both DEQ guideline distances as well as actual distances.
		b. Grazing Management Plan if any grazing activities are proposed at the land application site.
		c. Nuisance Odor Management Plan. *For systems with higher strength wastewater (wastewater with a greater potential to create odors), it is highly recommended that a Nuisance Odor Management Plan be prepared as part of the permit application.*
		d. Waste Solids Management Plan. *If waste solids are managed off-site, refer to IDAPA 58.01.02, Section 650 regarding sludge usage.*
		e. TDIS (Total Dissolved Inorganic Solids) Management Plan
		f. Runoff Management Plan addressing best management practices for minimization of runoff and ponding.

YES	NA	**Plan of Operation Checklist**
		Monitoring a. Description of the quantity of land applied wastewater is proposed to be monitored (methodology, frequency, location).
		b. Sampling and analysis plan for the land applied wastewater (constituents, disinfection level, methodology, frequency, location).
		c. Method of calculating hydraulic and constituent loading.
		d. If supplemental irrigation water is expected to be used, monitoring plan for quantity of land applied supplemental irrigation water (methodology, frequency, location).
		e. Soil monitoring plan (constituents, soil depths, methodology, frequency, location).
		f. Groundwater monitoring plan (constituents, methodology, frequency, location).
		g. Description of how crop uptake values are proposed to be determined (plant tissue monitoring, table values…).
		h. Other proposed monitoring for the site.
		i. Meteorological monitoring plan for site.
		Site Operations and Maintenance a. Description of who will operate and maintain the wastewater treatment facilities and land application site.
		b. Operator certification credentials—credentials currently held and any plans for future certifications.
		c. If a party other than the applicant operates and maintains the land application site, a copy of the signed contract or agreement outlining how the site will be operated to meet the conditions of the permit
		Solids Handling and Processing a. Detailed discussion of processing, storage, and disposal and common problems
		b. Site selection criteria
		Laboratory Testing a. Outline sampling and testing program
		b. Sampling location, specific tests, frequency c. List of laboratory references
		d. Interpretation and significance of lab results
		e. Sample laboratory worksheets

YES	NA	**Plan of Operation Checklist**
		Maintenance a. General maintenance information
		b. Preventative maintenance schedule
		c. Trouble-shooting charts or guides
		d. Maintenance record system
		e. Manufacturer's manuals
		Records and reports a. Describe importance of records & reports
		b. Describe daily operating log & provide sample format
		c. Describe maintenance records and show example
		d. Describe laboratory records & reports & provide sample
		f. Explain requirements of annual reports and show example
		j. How to report permit violations
		h. How to report accidents
		Store room and Inventory a. List of spare parts
		b. List of vendors and outside contractors and suppliers
		Personnel a. Manpower requirements and qualifications
		Emergency Operating Plan a. List of emergency numbers
		b. Description of emergency procedures

January 8, 1993

MEMORANDUM

To: Wastewater-Land Application Permit Program Regulated Community

From: Michael Cook, Program Coordinator
Wastewater-Land Application Permit Program

Subject: Transmittal of Standard Electronic Format for Land Application of Wastewater Program Monitoring Data.

Dear Member of the Regulated Community:

The following describes a major development in the Wastewater-Land Application Permit Program of which you must be aware.

THE NEED FOR PERMITTEES TO SUBMIT MONITORING DATA ON DISK

As a member of the Land Application of Wastewater regulated community, your facility is generating monitoring data on a regular schedule.

To date, the regulated community has been reporting this data in their annual reports hardcopy.

It is important that this data be reported in a uniform way by all permittees for use by Division of Environmental Quality (DEQ) to analyze site performance and permit compliance. Digital format (on a computer) is the most efficient means for DEQ analysis purposes.

ADVANTAGES TO SUBMITTING MONITORING DATA DIGITALLY

It is advantageous not only for the DEQ, but to the regulated community to submit monitoring data digitally. For example:

1) It makes analysis of data tremendously efficient, thus saving tax dollars,

2) It enables DEQ to efficiently evaluate existing monitoring protocols, in order to:

    a) modify frequencies and parameters of the monitoring program in many cases, and

    b) to assist in establishing de minimis criteria for different types of monitoring, and

3) Having data in digital format enables the permittee to evaluate the performance of his own site.

<u>THE NEED FOR PAST MONITORING DATA TO BE SUBMITTED ON DISK</u>

To date, all data generated as part of the Wastewater-Land Application Program has been submitted hardcopy. The Department recognizes the onerous task of entering past data and reporting this to the Department, but asks the regulated community to *please consider entering past data in the digital format provided*. Complete data sets would help in evaluating present monitoring parameters and frequencies.

<u>SOFTWARE DEVELOPED FOR DATA ENTRY</u>

DEQ has developed standard reporting spreadsheets which will take the place of the annual report form previously used. Hardcopy tables of data entered in the above mentioned tables will still be required in the annual report. Use of these spreadsheets to report data requires Lotus 1-2-3 software to enter data on.

If you do not have access to a computer or spreadsheet software please call this office (334-5898). We have an alternate stand alone data entry program you may use to enter data.

<u>SOFTWARE ENCLOSED FOR USE BY THE REGULATED COMMUNITY</u>

Attached is a disk which has the following seven Lotus spreadsheets on it:

- *wastewater,*
- *soils,*
- *lysimeter,*
- *ground water,*
- *hydraulic loading,*
- *management unit summary spreadsheet, and*
- *permit site summary.*

Attached are hardcopy examples of each of the spreadsheets. For each spreadsheet there are examples of both blank spreadsheets and those containing data.

File names for these spreadsheets are, respectively:

- *LWWWFL.WK1*
- *LWSOIFL.WK1*
- *LWLYSFL.WK1*
- *LWGWQL.WK1*
- *LWHYDL.WK1*
- *LWMSUMFL.WK1*
- *LWSSUMFL.WK1*

<u>ANNUAL REPORTING REQUIREMENT CHANGES</u>

The annual report submitted to DEQ should have the following:

- *hardcopy tables of data,*
- *narrative where appropriate and required by permit conditions,*
- *all monitoring data on the spreadsheets provided to you on disk.*

Enter only those data you are required to report. There may be some data you are not required to collect (e.g. lysimeter).

Where reporting conventions differ from the spreadsheet to your permit, please use conventions of the software. For example, Most permits have a Schedule B a "Treatment Field Monitoring" section. The information requested in the spreadsheets attached should be followed rather than that in this section, if there is a conflict.

MONITORING POINT LABELING

We have given serial numbers, as applicable, to each of the following monitoring points:

- *monitoring wells,*
- *wastewater sampling points,*
- *surface water sampling points,*
- *hydraulic management units (fields), and*
- *soil monitoring units.*

We have done this so that you may report data to DEQ in a standardized format assuring unique identifiers for all data.

You must use these serial numbers to identify what sampling point or area your data pertains to, and will use these designations when inputting data into the spreadsheets.

Attached are five tables which have listed the serial numbers you are to use. These are listed under your permit number.

ERRORS IN SERIAL NUMBER DESIGNATIONS OR DELINEATIONS

If you discover an error in our labeling of management units, soil monitoring units, monitoring wells, etc. please report these errors to Department immediately so they may be corrected before data is entered under incorrect designations.

HOW TO USE THE SOFTWARE TO INPUT DATA

As mentioned above, the spreadsheets are LOTUS (2.01) 1-2-3 spreadsheets. General instructions follow. More specific instructions peculiar to each spreadsheet are noted within the spreadsheets themselves.

General Instructions for inputting monitoring data into spreadsheets

- Enter your permit number only in the form LA-000XYZ. Note capitol LA, dash and six numbers following- nine characters in all.

- Enter all dates utilizing the Lotus @date() function formatted for long international format.

- Enter the version of Lotus you are using in the upper left corner of each spreadsheet.

- Enter your permit number in the upper left corner of each spreadsheet.

- Enter the reporting year in the upper mid or left corner of each spreadsheet.

- Enter data in the units specified in the respective column.

- Do not alter the spreadsheet heading columns, especially the row just above where you begin entering data.

- If a parameter was analyzed but not detected, enter a -1.0.

- If a parameter was not analyzed, leave the cell blank.

- Cells <u>in the top row only</u> not having an actual value or a -1.0, enter -33.3 (or xxx if a character or label cell) (this is for data translation purposes.

- If you are monitoring for parameters not included on the spreadsheet, add a column to the far right of the spreadsheet.

- Make careful note of all special instructions appearing on each spreadsheet.

<u>SPECIAL INSTRUCTIONS FOR HYDRAULIC APPLICATION RATE SPREADSHEET</u>

One hydraulic load entry for every calendar month is made for each management unit. By convention, date each calendar month entry as the 15th of each month [e.g. @date(92,9,15)].

<u>SPECIAL INSTRUCTIONS FOR GROUND WATER DATA SPREADSHEET</u>

Sampling Station is the township, range, section, 1/4,1/4,1/4 (numeric designator) location of the well. Example:

03N 04S 06bbc02

Please note capitol letters in township and range, spaces between them, preceding zeros if one digit, lower case 1/4, 1/4, 1/4 section designators, and a two digit numeric value if there is more than one well in the same 1/4, 1/4, 1/4 section.

<u>REGULATED COMMUNITY'S INPUT NEEDED ON SOFTWARE DESIGN</u>

To make this a useful tool for the regulated community to perform evaluations on their respective sites, DEQ welcomes your suggestions.

FURTHER QUESTIONS ABOUT THE SOFTWARE

Please contact me at 334-5898 if you have specific questions about this development in the Wastewater-Land Application Program.

ANNUAL REPORT FORM-LAND APPLICATION OF WASTEWATER PERMITTED FACILITY

This is your reporting form for your annual report as required in your land application of wastewater permit. It is important to note that **you are required to provide only that information specified in your permit**. Permits have different reporting requirements, some being more extensive than others.

You will need to make copies of parts B, D, E, F, and H if you have more than one field, sampling date, and/or monitoring well respectively.

Please report analysis results in units as given on the reporting forms.

We hope this form will be of help to you. If you have any questions regarding the use of this form, please contact the DEQ Field Office in your area.

Permitted Facility Name:		
Mailing Address:		
Permit No.:		
Date Submitted:		
Reporting period: (month/year)	from:	to:
Permit Expiration Date:		

Please note: If you have any questions regarding the completion of your annual report, please call the DEQ Wastewater Land Application staff at (208) 373-0502.

A. HYDRAULIC APPLICATION RATE (average rate over entire land application site)

1. Total acreage of land application site(s)
2. Hydraulic application rate:

Column No.					
1	2	3	4	5	6
Year	Month	Million Gallons Wastewater	Acre-Inches Per Acre Wastewater	Million Gallons Supplemental Irrigation Water	Acre Inches Per Acre Irrigation Water
	January				
	February				
	March				
	April				
	May				
	June				
	July				
	August				
	September				
	October				
	November				
	December				
	Totals				
		Million Gallons	Acre-Inches Per Acre	Million Gallons	Acre- Inches Per Acre

Column 1: Enter the appropriate year (e.g. 1995) that the monthly loading took place.
Column 3: Enter total wastewater applied in million gallons.
Column 4: Multiply each monthly entry in column 3 by 36.83 to get acre inches; then divide by total acres to get acre inches per acre.
Column 5: Enter estimate of supplemental irrigation water applied in million gallons.
Column 6: Multiply Column 5 by 36.83 and then divide by the total acreage to get acre-inches per acre of supplemental irrigation water.

B. HYDRAULIC APPLICATION RATE BY MANAGEMENT UNIT

Please use a separate page for each Hydraulic Management Unit.

1. Hydraulic Management Unit __________ Acres ______ (field or parcel #)
2. Hydraulic application rate:

Column No.					
1	2	3	4	5	6
Year	Month	Million Gallons Wastewater	Acre-Inches Per Acre Wastewater	Million Gallons of Supplemental Irrigation Water	Acre Inches Per Acre Irrigation Water
	January				
	February				
	March				
	April				
	May				
	June				
	July				
	August				
	September				
	October				
	November				
	December				
	Totals				
		Million Gallons	Acre-Inches Per Acre	Million Gallons	Acre-Inches Per Acre

Column 1: Enter the appropriate year (e.g. 1995) that the monthly loading took place.
Column 3: Enter total wastewater applied in million gallons.
Column 4: Multiply each monthly entry in column 3 by 36.83 to get acre inches; then divide by total acres to get acre inches per acre.
Column 5: Enter estimate of supplemental irrigation water applied in million gallons.
Column 6: Multiply Column 5 by 36.83 and then divide by the total acreage to get acre-inches per acre of supplemental irrigation water.

C. NITROGEN LOADING FROM WASTEWATER AND FERTILIZER

1. Average concentration of nitrogen
   (TKN-N + NO_3-N) in wastewater (ppm)

2. Pounds of Nitrogen per acre per year by Hydraulic Management Unit

Hydraulic Management Unit (field or parcel #)	Nitrogen from Wastewater applied (pounds per acre per year)[1]	Nitrogen from Fertilizer Applied (pounds per acre per year)

1: Multiply average wastewater concentration of nitrogen (in mg/L) by total wastewater volume in MG applied to management unit calculated in B 2 above. Multiply this product by 8.327 and divide by the acreage of the management unit.

2: Enter the amount of fertilizer applied to the management unit in pounds per acre per year.

D. COD LOADING FROM WASTEWATER FOR EACH HYDRAULIC MANAGEMENT UNIT

Please use a separate page for each Hydraulic Management Unit.

1. Hydraulic Management Unit
2. Flow weighted (average) concentration of COD in wastewater (ppm)
3. Pounds per acre per day by month (below)

Column No.			
1	2	3	4
Year	Month	COD applied (pounds)	COD applied (pounds per acre per day)
	January		
	February		
	March		
	April		
	May		
	June		
	July		
	August		
	September		
	October		
	November		
	December		
Pounds per acre per day (average)[1] growing season			
Pounds per acre per day (average)[2] non-growing season			

Column 1: Enter appropriate year (eg 1995) that the monthly loading took place.
Column 3: Multiply average concentration of COD by monthly wastewater volume in MG applied to management unit calculated in B2 above. Multiply this product by 8.327.
Column 4: Divide column 3 by the number of days in the month <u>and</u> by the acres of the Hydraulic Management Unit.

FOOTNOTES

1 Add COD applied for the growing season months and divide by the total days to get pounds per acre per day of the growing season. Then divide by the acreage of the management unit.

2 Add COD applied for the non-growing season months and divide by the total days of the non-growing season. Then divide by the acreage of the management unit.

E. WASTEWATER CHEMISTRY DATA

Please use a separate page for each sampling point (if more than one) or if there are more than four sampling dates.

Sampling Point Identification #

Parameter	Sample Date MM/DD/YY			
Total Kjeldahl Nitrogen (TKN) (ppm)				
Nitrate (ppm)				
Ammonia (ppm)				
Biological Oxygen Demand (BOD) (ppm)				
Chemical Oxygen Demand (COD) (ppm)				
Sodium Adsorption Ratio (SAR)				
pH (S.U.)				
Sodium (ppm)				
Chloride (ppm)				
Chlorine Residual(ppm)				
Potassium (ppm)				
Phosphorus (ppm)				
Total Coliform (count/100ml)				
Specific Conductance (umhos/cm)				
Total Dissolved Solids (ppm)				
Total Suspended Solids (ppm)				
Volatile Dissolved Solids (ppm)				

F. CROP

Please use a separate page for each Hydraulic Management Unit.

1. Hydraulic Management Unit

2. Crop Nutrient Uptake

	Crop # 1	Crop # 2	Crop # 3
1. Crop harvested (type)			
2. Crop yield[1] (tons/acre, bu/acre etc)			
3. crop yield (convert to lbs/acre)[2]			
4. protein percentage			
5. protein-Nitrogen percentage[3] (TKN)			
6. protein-nitrogen removed (lbs/acre)[4] (TKN)			
7. Nitrate-N concentration (ppm)			
8. Nitrate-N removed (lbs/acre)			
9. Total nitrogen removed (add No. 6 & No. 8)			

1: If only a portion of hydraulic management unit was used to grow a crop, express 1 crop yield using the entire acreage of the management unit. For example if 300 tons of hay was taken off 50 acres of a 100 acre management unit, the yield would be 3 tons per acre.

2: If tons, multiply by 2,000; if bushels, multiply by weight of bushel.

3: Divide protein percentage by 6.25 to get protein-nitrogen percentage (except for small grains which factor is 5.70)

4: Multiply No.5 (protein nitrogen percentage) by No.3 (crop yield). Please note that nitrogen concentration must be expressed at the same moisture percentage as yield. If they are not the same, the former must be corrected to the appropriate moisture percentage.

G. SOIL CHEMISTRY DATA

Please use a separate page for each Soil Monitoring Unit and/or sampling date.

Date Sampled _________ Soil Monitor Unit

	DEPTH		
Parameter	0-12"	12-24"	24-36"
Percent[1] organic Matter			
Nitrate-Nitrogen (ppm)			
Ammonia-Nitrogen (ppm)			
Sodium Adsorption Ration (SAR)			
Electrical Conductivity (EC) umhos/cm			
Cation Exchange Conductivity (CEC) (meq/100g)			
Texture (USDA texture)			
Percent moisture[1]			
Sodium (ppm)			
Chloride (ppm)			
pH (S.U.)			
Potassium (ppm)			
Plant Available Phosphorus (ppm)			
DTPA - Iron			
DTPA - Manganese			

1: Expressed as percent of oven dry weight of soil.

H. GROUND WATER DATA

Please use a separate page for each well.

Well Identification #

Parameter	Sampling Date MM/DD/YY			
TKN (ppm)				
Nitrate(ppm)				
COD (ppm)				
Iron (total) (ppm)				
Manganese (total) (ppm)				
pH (S.U.)				
Sodium (ppm)				
Chloride (ppm)				
Potassium (ppm)				
Specific Conductance (umhos/cm)				
Total Dissolved Solids (ppm)				
Static Water Level depth below ground surface (ft)				
Static Water Level (elevation above MSL) (ft)				

I. Lysimeter Data

Please use a separate page for each Lysimeter.

Lysimeter Identification #

Parameter	Sampling Date MM/DD/YY			
TKN (ppm)				
Nitrate(ppm)				
COD (ppm)				
Iron (total) (ppm)				
Manganese (total) (ppm)				
pH (S.U.)				
Sodium (ppm)				
Chloride (ppm)				
Potassium (ppm)				
Specific Conductance (umhos/cm)				
Total Dissolved Solids (ppm)				

J. GROUND WATER STATUS REPORT- An interpretive report of the year's data with respect to ground water impacts by the facility (Please Attach).

A.13 Wastewater Land Application Sites Overlying Designated Special Resource Water

The Ground Water Rule, IDAPA 58.01.11.006, establishes policies to protect ground water quality, maintain beneficial uses, differentially protect ground water, and establish numerical and narrative ground water quality standards. IDAPA 58.01.11.300.01a designates the Spokane Valley – Rathdrum Prairie Aquifer as a sensitive resource. IDAPA 58.01.11.150.02 (Table 1) prescribes the highest level of protection for this aquifer category.

A.13.1 Land Application of Wastewater Over the Spokane Valley-Rathdrum Prairie Aquifer

Wastewater-land application systems overlying designated sensitive resource water may require additional considerations prior to permit issuance to assure the integrity of the special resource water remains intact. These considerations include but are not limited to: an in-depth evaluation of the nutrient transport to the sensitive resource water if the land application system recharges the sensitive resource water, background information on limiting nutrients in the sensitive resource water, and a design approach for limiting the nutrient transport to the sensitive resource water. This includes calculation of the nitrogen and phosphorus balance and calculation of loss to ground water.

To date, the sensitive resource water designation has rarely been used for ground water. However, extensive work has and is continuing to be done in North Idaho on land application systems overlying the SpokaneValley-Rathdrum Prairie Ground Water Aquifer.

A.13.2 Guideline Development

The CH_2M-Hill "Rathdrum Prairie Land Application Feasibility Study" was published in November 1990. Based on the information from this feasibility study, a pilot project was conducted and a report (Hayden Land Application Pilot Study) published in June 1994 by CH_2M-Hill and J. A Riley. The information from these two reports and the status of the Spokane Valley-Rathdrum Prairie as a state designated sensitive resource water, and a federally designated sole source drinking water aquifer, resulted in EPA providing grant monies for the development of guidelines. The guidelines are to specifically address the land application of wastewater over the Spokane Valley-Rathdrum Prairie Aquifer. The guidelines were developed by a Technical Advisory Group in cooperation with DEQ's North Idaho Regional Office.

Special Supplemental Guidelines

Spokane Valley-Rathdrum Prairie Aquifer
Wastewater Land Application

January, 1995

Idaho Department of Health and Welfare
Division of Environmental Quality

**Spokane Valley-Rathdrum Prairie Aquifer Wastewater Land Application
Special Supplemental Guidelines**

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Spokane Valley-Rathdrum Prairie Aquifer Wastewater Land Application
Special Supplemental Guidelines

CONTENTS (continued)

Part 1: The Spokane Valley-Rathdrum Prairie Aquifer

THE SPOKANE VALLEY-RATHDRUM PRAIRIE AQUIFER

This document sets guidelines for managing one of the pollution sources of the Spokane Valley-Rathdrum Prairie Aquifer: municipal wastewater. The guidelines establish conditions under which secondarily-treated municipal wastewater can be spray irrigated over the aquifer in Idaho without causing contamination to the groundwater.

The Spokane Valley-Rathdrum Prairie Aquifer lies below the surface of about 325 square miles of north Idaho and eastern Washington, and is the sole source of drinking water for the region's 400,000 people. The aquifer is composed of glacial outwash soils, making it extremely permeable, high in groundwater velocity and susceptible to contamination. Unfortunately, the vulnerability of the resource has been proven with detections of nitrates, industrial solvents and pesticides in public water supply wells. Despite many protection efforts, a few water supply wells have had to be abandoned.

Coeur d'Alene Lake and the Spokane River contribute about one-third of the flow of the aquifer. The Hayden, Spirit, Twin, Hauser and Blanchard lake watersheds make up most of the additional flow crossing the state line. At the Idaho/Washington border, total flow is estimated to be 750 cubic feet per second or 485 million gallons per day. The movement of water particles ranges from less than a foot to almost 50 feet per day, as it flow west from Idaho into Washington. The depth to the water table varies from 400 feet to only 50 feet at some points in Washington.

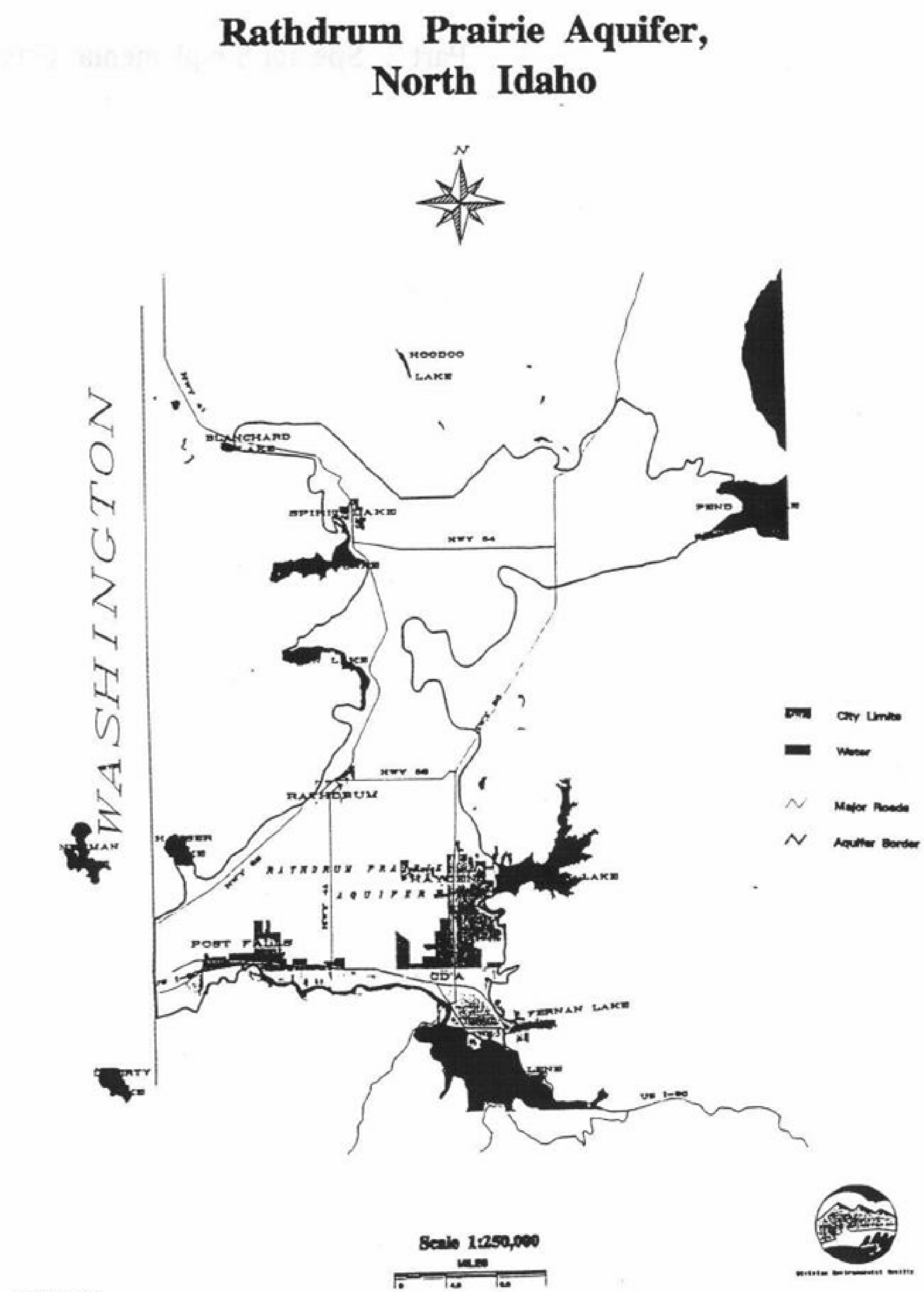
In 1978 the Spokane Valley-Rathdrum Prairie Aquifer was declared a "sole source" drinking water supply pursuant to Section 1424e of the Safe Drinking Water Act. This designation requires all projects receiving any federal funding to implement aquifer protection measures. In addition, it proclaimed the significance of this groundwater resource to the region as well as provided support for local protection efforts.

An aquifer protection project, administered in Idaho by the state Department of Health and Welfare, Division of Environmental Quality (DEQ) and the Panhandle Health District, has been in place for many years. The overriding premise for the protection project is this: Prevent contamination before it occurs. The goal is to avoid contamination and remediation, which can be extremely costly. To do this, the project has programs which can be divided into three main categories: 1) Managing pollution sources; 2) Promoting public awareness; and 3) Coordinating and cooperating with other public agencies.

The Special Supplemental Guidelines for land application over the Rathdrum Aquifer fall into the category of "managing pollution sources." Studies in the 1970s found that 60 percent of all aquifer pollutants were from sub-surface septic systems and 30 percent were from stormwater. The remaining 10 percent resulted from chemical and petroleum products.

To address the problem of septic discharges, the Panhandle Health District in 1977 adopted a regulation limiting new construction to one house per five acres over the aquifer. Higher housing densities are allowed in Sewage Management Areas (SMA). The health district enters into legally binding agreements cities and sewer districts over the aquifer to establish boundaries for SMAs. The cities agree to provide sewer to the higher density developments.

Since 1977, sewer construction has helped to mitigate aquifer contamination. There are now three municipal wastewater treatment plants treating the area's sewage and discharging effluent to the Spokane River. However, the river is reaching its assimilative capacity. The land application guidelines were developed to give the growing cities over the Rathdrum Aquifer another option for sewage disposal, while still maintaining high quality drinking water for the region's residents.


Rathdrum Prairie Aquifer,
North Idaho
N
WASHINGTON
HOODOO
LAKE
BLANCHARD
SPIRIT LAKE
HWY 54
PEND
HWY 53
RATHDRUM
RATHDRUM PRAIRIE
AQUIFER
HWY 41
POST FALLS
CD'A
FERNAN LAKE
US I-90
City Limits
Water
Major Roads
Aquifer Border
Scale 1:250,000

3

Part 2: Special Supplemental Guidelines

I. Introduction

A. Intent and Goals

This document is an appendix to the ***Interpretive Supplement to the "Guidelines for Land Application of Municipal and Industrial Wastewater, March, 1988"*** (***Supplement***) prepared by the Permits and Enforcement Bureau, Division of Environmental Quality, Idaho Department of Health and Welfare. The intent of this document is to present specific guidelines for the design and operation of wastewater land application facilities located over the Spokane Valley-Rathdrum Prairie Aquifer (Rathdrum Aquifer). The goal of this document is to provide an environmentally sound wastewater treatment and disposal alternative for communities near and over the Rathdrum Aquifer. This document will be reviewed and revised on a regular basis.

B. Special Resource Water and the Idaho Water Quality Standards

The Rathdrum Aquifer is designated a Special Resource Water under the ***Idaho Water Quality Standards and Wastewater Treatment Requirements***. Special Resource Waters are specific segments or bodies of water recognized as needing intensive protection to preserve outstanding characteristics or to maintain current beneficial use. The ***Idaho Water Quality Standards and Wastewater Treatment Requirements*** (IDAPA 58.01.02.299.01) specifically states:

> "The waters of the Spokane Valley-Rathdrum Prairie Aquifer, as described by the US Environmental Protection Agency in its designation as a 'sole source' aquifer under Section 1424(e) of the Safe Drinking Water Act, must not be lowered in quality, as relates to appropriate beneficial uses, as a result of a point source or non-point source activity unless it is demonstrated by the person proposing the activity that such change is justifiable as a result of necessary economic or social development." (1-30-80)

In 1990 the Idaho Division of Environmental Quality (DEQ) selected a consultant to study application of secondary treated municipal wastewater to the land surface located above the Rathdrum Aquifer. The completed report entitled ***Rathdrum Prairie Land Application Feasibility Study*** was cautiously optimistic that land application is an environmentally sound alternative for wastewater treatment over the Rathdrum Aquifer. Although the report stated that potential contaminants may be present in the wastewater, it suggested that a properly designed, sited and operated system could minimize contaminant migration, producing minimal ground water degradation.

In 1993 the Idaho Division of Environmental Quality (DEQ) commissioned a consultant to report on a wastewater land application pilot study over the Rathdrum Aquifer. This cooperative project between DEQ, the Hayden Area Regional Sewer Board and Spokane County was conducted to demonstrate land application technology and to obtain environmental data to improve the accuracy of the impact assessment and, ultimately, to determine the feasibility of using land application over the Rathdrum Aquifer as a permanent solution to wastewater treatment and disposal. The result of this work, the

Hayden Land Application Pilot Study, provides the information necessary to comply with the water quality regulations for initially establishing best management practices specific to land over the Rathdrum Aquifer.

C. Acknowledgements: Rathdrum TAC and the CH_2M-Hill Report

These supplemental guidelines are based on work conducted between 1990 and 1994 as a cooperative effort between the Hayden Area Regional Sewer Board (HARSB), the Division of Environmental Quality (DEQ), Spokane Water Quality Management Program and select individuals who served on a Technical Advisory Committee (TAC). A consulting firm, CH_2M-Hill, prepared the feasibility study, subcontracted site monitoring to Dr. John Riley, and presented the final data interpretation and report in cooperation with Dr. Riley.

The Hayden Area Regional Sewer Board (HARSB) purchased the center pivot irrigation equipment for applying wastewater and provided the piping to the pilot study field. DEQ and Spokane County, through EPA grant awards, funded the consultant to monitor and report on the pilot study site. The pilot study site was operated as a cooperative effort in the 1992 and 1993 growing seasons. At the direction of the TAC, the final pilot study report, including conclusions and recommendations, was published in June 1994. All consulting work was completed by CH_2M-Hill and its subconsultant, Dr. John Riley. The HARSB and its consultant, Kimball Engineering, are recognized for their efforts and contributions in helping make this project possible.

The Technical Advisory Committee was created in May 1991 to provide guidance to DEQ regional office staff in crop selection, center pivot system operation, soil moisture monitoring, and numerous other technical areas. Frequency of meetings depended on the amount of site activity and varied from monthly, at the start of the project, to about twice a year in late 1993 and 1994. The technical advice and direction from the TAC made the project a success. The members of the Technical Advisory Committee are acknowledged below. Their help has been greatly appreciated.

Rathdrum Aquifer Land Application Technical Advisory Committee Members

Dick Jacquot (Farmer on Land Application Site) - Kootenai County Soil Conservation District
Ken Babin - Panhandle Health District
David Brown and Kim Golden - USDA, Soil Conservation Service
Vickie Parker-Clark - University of Idaho Cooperative Extension Service
Stan Miller - Spokane County Public Works
Jonathan Williams - US EPA, Region X
Jim Kimball and Mike Wilson - Kimball Engineering (Hayden Area Regional Sewer Board)
Dale Arnold - City of Spokane, Environmental Programs Department
Dr. John Riley - Consulting Hydrogeologist (Consultant)
Larry Comer - Welch, Comer Engineers (Kootenai Perspectives Representative)

D. Pilot Study Report Conclusions and Recommendations

CH_2M-Hill's report, ***Hayden Land Application Pilot Study***, presented the following conclusions and recommendations:

<u>Conclusions</u>

1. Land application of treated effluent has occurred over the Rathdrum Prairie Aquifer under carefully managed conditions with limited increases for monitored constituents in vadose zone water.

2. Irrigation scheduling using daily soil moisture measurements can be used to minimize migration of nutrients past the root zone.

3. Nutrients can be applied with wastewater effluent with little or no observable migration beyond the root zone of the crops.

4. The tradeoffs between crop production and fertilizer use should be evaluated for each site considering the potential for nutrient migration and the need to establish and maintain vigorous crops.

5. Crop selection is critical to the successful operation of a land application system.

<u>Recommendations</u>

1. Limit the hydraulic loading rate to the mean monthly crop water requirement.

2. Limit nitrogen to crop nitrogen requirements.

3. Select deep rooting crops with high uptake rates.

4. Apply effluent with an irrigation system that is well maintained and efficient in distributing water evenly across the site.

5. Assess the site soils, hydrology, and climate.

6. Prepare a management plan that integrates effluent management with suitable agricultural best management practices (BMPs).

7. Phosphorus should also be monitored, but annual application rates need not be limited to agronomic rates.

8. To determine acceptability of loading rates beyond the agronomic rates recommended, additional studies are needed.

II. Wastewater Land Application

A. Types of Wastewater Land Application Allowed

Slow rate wastewater land application systems located over the Rathdrum Aquifer are allowed when designed and operated in accordance with these guidelines. "Slow rate" application is a controlled distribution of wastewater to the land surface by spraying or surface spreading to support plant growth. Treatment is accomplished through physical, chemical and biological processes occurring in the plant/soil matrix. Overland flow and rapid infiltration land application systems are not allowed over the Rathdrum Aquifer.

B. Application Season

The season for wastewater land application over the Rathdrum Aquifer will be limited to the period when the specific crop water requirement exceeds the average monthly precipitation. Climatic conditions in the Rathdrum Prairie area generally restrict land application to the period: May 1 to October 31. The hydraulic requirements of specific crops may further shorten the application season.

C. Precipitation and Climate

The Rathdrum Prairie area is generally subhumid with warm, dry summers and cold, wet winters. The average annual precipitation is about 26 inches in the Coeur d'Alene area; but significant local variation is present, particularly west across the prairie near the state line where reported annual precipitation is about 20 inches.

When designing a land application facility, effective precipitation, rather than precipitation values, should be used. "Effective precipitation" is a calculated value (see the ***Supplement***) that represents the precipitation during the crop-growing season that is available to meet the consumptive water requirements of the crop.

D. Crop Selection

The site crop is a critical element of a successful land application system over the Rathdrum Aquifer, and each land application system should have a Crop Management Plan. The Crop Management Plan should include:

1. <u>Selection criteria</u> should be related to soil parameters and management capacities. Deep rooting crops are recommended. Possible crops include alfalfa, grass hay, small grains, turf grass, and poplar trees. Consultation with agronomic experts, such as the County Extension Service, is recommended.

2. <u>Harvest schedule</u> should be established and related to wastewater production and storage. For example, the harvesting practice for bluegrass precludes application from about mid-June until mid-August, making this an unsuitable sole crop for a municipal land application site where flows are constant or higher in the summer or when sufficient wastewater storage is unavailable.

3. Hydraulic requirements for each crop should be included. Limited crop hydraulic information may be found in the ***Supplement***.

4. Nutrient requirements for each crop should be established. Since wastewater cannot provide enough nutrients for crop sustainability, supplemental nutrients should be provided. Studies have shown that frequent application of low fertilizer concentrations during the active plant growing periods are more effective than large, infrequent fertilization in limiting nutrient migration through the soil profile. Fertilizer type, application rate and application frequency should be established in the Crop Management Plan; and any changes should be reviewed and approved by DEQ.

5. Rotation schedule for each crop should be provided, when applicable.

6. Pest control strategy for each crop should be established. Pesticide type, application rate and application frequency should be established in the Crop Management Plan; and any changes should be reviewed and approved by DEQ.

E. Application Rates

The total application of water from all sources on wastewater land application sites located over the Rathdrum Aquifer is limited to the crop water requirement. The water used to satisfy the crop water requirement, also called the crop evapotranspiration, may include: precipitation, irrigation water (ground water and/or surface water), and treated wastewater.

crop water requirement = precipitation + irrigation water + treated wastewater

For wastewater land application sites located over the Rathdrum Aquifer, the hydraulic loading rate is identical and equal to the crop water requirement. The actual daily application volumes may vary daily and are affected by crop type, plant growth cycle, precipitation, evaporation, and available water capacity of the soil.

1. Design application rates: For initial design, the wastewater application rate will be the estimated crop water requirement minus the effective precipitation based on a 5 to 10 year precipitation recurrence. The results of a statistical analysis of precipitation in the Coeur d'Alene area from 1950 through 1993 (taken from an unpublished 1994 DEQ document "Coeur d'Alene Precipitation Analysis and Recommended Precipitation Values for Wastewater Land Application on the Rathdrum Prairie") are provided in the following table:

Recommended Design Precipitation Values for Rathdrum Prairie Sites (based on 1950 - 1993 Coeur d'Alene area data)			
Month	Average Precipitation	Design Precipitation	Recurrence Period
May	1.99"	3.15"	6.7 years
June	2.00"	3.04"	5.4 years
July	0.86"	1.65"	6.1 years
August	1.24"	2.32"	6.3 years
September	1.11"	1.79"	6.1 years

2. Supplemental irrigation: Since 5 to 10 year recurrence precipitation values are used to compute design wastewater application rates, in most years supplemental irrigation of the crop will be needed to insure vital plant growth. Supplemental irrigation can be treated wastewater, agricultural irrigation water, or a combination of the two.

3. Daily application rates: For daily operations, soil moisture instrumentation will be used to determine application rates and frequency. Soil moisture instrumentation will be installed on the site and will be monitored daily during the application season. The initial soil moisture threshold is 10 centibars, and wastewater application is allowed only when the soil moisture value (in centibars) as measured by the site instrumentation is equal to or drier than the threshold. Wastewater will not be applied when the soil moisture value (in centibars) as measured by the site instrumentation is wetter than the threshold value, except during periods of extreme climatic conditions. Threshold values wetter than 10 centibars may be approved by DEQ if satisfactory scientific evidence is presented that the lower values will not increase wastewater movement past the root zone.

4. Extreme climatic conditions: During months when precipitation exceeds the 5 to 10 year recurrence design precipitation values, wastewater may be applied at the design rate even if the soil moisture levels are high or saturated soil conditions are present.

F. Nutrient Loadings

1. Nitrogen will be limited to the crop nitrogen requirements. For most crops, nitrogen sources are wastewater and fertilizers. The nitrogen application rate should include a fraction above crop uptake to allow for losses that occur in the soil. The fraction should be based on soil and soil water testing, but may initially be 10%-20%. Since nitrate is more mobile than other forms of nitrogen, if it is used, then soil moisture monitoring should be used to schedule irrigation and limit conditions that enhance leaching.

2. Phosphorous should also be monitored, but phosphorous application rates are not limited to the crop requirements. Most soils have a generous, but not unlimited, capacity to absorb phosphorous and limit its mobility. However, since this capacity is finite, the soil phosphorous level should be monitored to ensure the soil capacity is not exceeded.

G. Higher Application Rates

To determine acceptability of wastewater application rates beyond the rates recommended, additional studies are needed. The extent of the studies will depend on loading rates, nutrient forms, site specific conditions, and management objectives. For example, the form and concentration of nitrogen plays a significant role in evaluating application rates. Application of effluent at rates above monthly hydraulic rates may be practical if nitrogen is in the form of ammonia. However, because of concerns regarding leaching of synthetic organics and other environmental contaminants without sufficient treatment, an extensive study may be justified. These studies may include:

- More extensive and frequent effluent monitoring
- Unsaturated zone monitoring below the root zone
- Ground water monitoring
- Crop suitability

Application rates beyond the recommended values may be acceptable if additional technical information and studies are provided that substantiate aquifer protection.

H. Commercial/Industrial Wastewater

Land application of commercial or industrial wastewater on the Rathdrum Prairie is not allowed. Exceptions may be granted only if the constituents and concentration levels in the industrial/commercial wastewater do not vary significantly from treated municipal wastewater.

III. Site Selection Criteria

A. General

The evaluation of a site as a potential wastewater land application area requires consideration of a number of related site specific elements. An unacceptable evaluation on just one site element is sufficient to eliminate that site from consideration. Although the major site characteristics are discussed in this section, other site specific elements should also be considered and evaluated as warranted.

B. Soil

Not all soils over the Rathdrum Aquifer are suitable for land application of wastewater. Excessively stony and drained soils, such as the Garrison very stony silt loam, show poor potential for land application treatment of wastewater and should be avoided. Water holding capacity of the soil is a critical factor in applying wastewater without carrying nutrient load below the root zone. Soils that are excessively drained often do not have the capacity to hold the wastewater load long enough for the plants to extract nutrients. The result is poor crop production and excessive leaching.

Sites with soil classifications having good soil moisture holding capacity will be considered for permitting. A soil survey of the proposed site that includes test borings and soil classifications should be performed by a qualified soil scientist. Past cropping history of the site will also give an insight into the soil type and water holding capacity. Therefore, this information should also be submitted with an application.

C. Buffer Zones

The buffer zone for wastewater land application sites over the Rathdrum Aquifer will be as specified in the ***Supplement***, Table 3 - Municipal Wastewater Buffer Zone Treatment Sites. The development potential near potential land application sites will be considered: sites in "rural" areas that have a potential of being adjacent to "suburban or residential" uses will be evaluated for buffer zones according to the other uses.

D. Land Use

Land use suitability determination for a wastewater land application site is the responsibility of local government. Anyone proposing a wastewater land application project over the Rathdrum Aquifer should inform the responsible planning and zoning department and obtain preliminary zoning approval prior to submitting an application to DEQ. Wastewater land application projects may be allowed in an agricultural or rural zoning, but such projects in other zone classifications may require a conditional use permit and may require a public hearing. Public meetings to present the proposed land application project to neighbors and the community are recommended.

E. Wellhead Protection

The well head protection zone for wastewater land application sites over the Rathdrum Aquifer will be as specified in the ***Supplement***, Buffer Zones - Wellhead Protection. Drinking water wells closer than 100 feet to the land application site are not allowed. Wells between 100 feet and ¼ mile from the land application site are considered within the influence zone of the site and should be evaluated according to the ***Supplement*** by a qualified hydrogeologist or professional engineer with appropriate expertise.

IV. Wastewater Lagoons

A. General

Wastewater treatment systems near the Rathdrum Aquifer may be classified into two categories: single outfall systems and multiple outfall systems. Single outfall systems, such as Spirit Lake, use land application exclusively and, therefore, should completely contain all treated wastewater for treatment and disposal during the application season. Multiple outfall systems, such as Hayden, use an outfall to surface water during the non-growing season. Wastewater lagoon design for either system type should be based on a detailed monthly water balance.

B. Single Outfall Systems

Single Outfall Systems should have storage lagoon volume to completely store treated wastewater for the 6 - 7 month period when land application is not allowed. A detailed lagoon water balance should be created for this system that considers: precipitation, evaporation, seasonal wastewater variances, and temporary growing season application cessation.

C. Multiple Outfall Systems

Multiple Outfall Systems should have two storage lagoons systems: operations lagoons and seasonal lagoons. Operations lagoon storage should be provided for temporary growing season application cessation due to weather conditions or harvest schedules. This lagoon volume should be based on an analysis of the climate and the crop, but it should accommodate at least one week of wastewater flow during the application season. Seasonal lagoon storage should be provided for periods in the fall and spring when neither surface water discharge nor land application is allowed. This storage lagoon volume should be based on an analysis of average climatic and environmental conditions.

D. Lagoon Criteria

Wastewater lagoons often contain millions of gallons of partially treated sewage that is a potential ground water contamination source. Wastewater lagoons located over the Rathdrum Aquifer should be designed and maintained to a higher standard than lagoons in other areas due to the adverse affects a leaking lagoon would have to the aquifer. All lagoons should meet the leakage criteria (500 gallons per day per acre for most lagoons) found in the Recommended Standard for Wastewater Facilities published by the Great Lakes-Upper Mississippi River Board of State Public Health and Environmental Managers (10 State Standards). The following criteria will be used for lagoons located over the Rathdrum Aquifer:

1. <u>Small lagoons and temporary lagoons</u>: Small lagoons are lagoons with a design volume less than 500,000 gallons. Temporary lagoons are lagoons that store wastewater for less than two months annually. Small lagoons and temporary lagoons should be constructed with a synthetic liner (60 mil polyethylene or equal), and they should be leak tested at least once every five years.

2. <u>Large lagoons and storage lagoons</u>: Large lagoons are non-temporary lagoons with a design volume greater than 500,000 gallons. Storage lagoons are lagoons that store wastewater for more than two months annually. Large lagoons and storage lagoons

should be constructed with a synthetic liner (60 mil polyethylene or equal), and they should have a second level of protection approved by DEQ that includes, but is not limited to, the following:

a) a system that continuously monitors lagoon seepage, or
b) a double liner system, or
c) additional liner strength and reliability (such as extra thickness)

V. Monitoring and Sampling

A. General

Monitoring and sampling are essential elements of managing land application sites over the Rathdrum Aquifer to ensure that land application activities are not affecting the aquifer water quality. A monitoring and sampling program is unique to each land application site, but the program should include:

1. wastewater effluent sampling
2. soil moisture monitoring
3. soil water sampling
4. soil sampling
5. ground water monitoring and sampling

All monitoring and sampling will be in accordance with the *Water and Soil Monitoring* section of the ***Supplement***.

B. Wastewater Effluent Sampling

The analytical parameters for wastewater effluent sampling will be in accordance with the ***Guidelines for Land Application of Municipal and Industrial Wastewater*** and will include, but not be limited to: TDS, COD, BOD_5, TSS, total coliform, pH, phosphorous, TKN, ammonia nitrogen and nitrate nitrogen. The frequency of sampling is dependent on the consistency of the effluent constituents, but in no case will the frequency be less than once per year during the land application season.

Complete wastewater characterization is a necessary element of a properly designed and operated land application system. Although many potentially toxic constituents receive some degree of treatment (volatilization and biogradation of organics) or are retained in the soils (heavy metals), some toxic elements may have a detrimental effect on the crops, livestock or the ground water. The land applied wastewater should not create phytotoxicity and food chain contamination. Regular testing for cadmium, copper, zinc, nickel, and other potentially toxic constituents may be necessary. Wastewater facilities that have industrial or commercial contributions should have an active and effective pretreatment program.

C. Soil Moisture Monitoring

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Soil moisture will be used to determine the irrigation schedule, and soil moisture data will be used to manage crop vitality. A tensiometer or soil moisture sensor clusters will be installed in accordance with the monitoring plan, and soil moisture data will be recorded daily during the application season. A soil moisture based irrigation strategy may allow more effluent application in drier years. (See this document, Section II, Paragraph E.3. *Daily Application Rates*)

D. Soil Water Sampling

Soil water sampling will be in accordance with the *Water and Soil Monitoring* section of the ***Supplement***. At least two lysimeter sampling points will be used at each sampling station: within the root zone and immediately below the root zone.

E. Soil Sampling

Soil sampling will be in accordance with the *Water and Soil Monitoring* section of the ***Supplement***. In addition to the analytical parameters specified in the ***Supplement***, phosphorous will also be sampled and monitored.

F. Ground Water Sampling and Testing

Each land application site will have a ground water monitoring plan. Ground water sampling and analytical parameters will be in accordance with the ***Supplement***. Each site will have at least three ground water monitoring wells: one up gradient and two down gradient of the ground water flow. Before land application commences on a site, sampling and testing will determine the existing background levels of the sampling parameters. The land application management goal is: no detectable increase in wastewater related constituents in the ground water as determined by the monitoring program.

VI. Operations and Maintenance

A. General

A successful land application system requires diligent operations and maintenance. Individuals who manage the site should have expertise and knowledge of agricultural practices as well as wastewater treatment processes. According to the pilot study report, wastewater land application over the Rathdrum Aquifer can comply with the intent of the Special Resource Water designation only **under carefully managed conditions**.

B. Management Plan

Each land application site should have a management plan that integrates effluent management with suitable agricultural best management practices. The plan should address specific program elements that include: effluent, nutrients, crop selection, crop vitality, soil moisture, chemical fertilizers, and pesticides. A higher level of chemical fertilizer management than employed in normally accepted agricultural practices may be necessary to limit nutrient migration below the root zone.

C. Daily Soil Moisture Monitoring and Irrigation

A daily reading of soil moisture at several places on a land application site will allow integration of crop needs and wastewater application. A soil moisture reading that indicates soil saturation needs to be established for each land application site. (See this document, Section II, Paragraph E.3. *Daily Application Rates*.) Irrigation based on soil moisture will allow higher application rates than average in some of the drier or warmer growing seasons.

D. Crop Production and Fertilizers

The primary function of a wastewater land application site is the treatment of wastewater. While a viable and healthy crop is necessary for optimum wastewater treatment, chemical fertilizers that are commonly used to promote crop production can become the primary nutrient source for aquifer degradation. Fertilizer application should be balanced -- sufficient to produce good plant growth but insufficient to produce a detectable nutrient level below the plant root zone.

E. Disinfection

Wastewater disinfection will be as specified in the ***Supplement*** as related to buffer zone requirements.

F. Irrigation Systems

The irrigation system should be well maintained and efficient in distributing the water evenly across the site. The goal for irrigation efficiency is 75-90%. The irrigation system should be operated to reduce spray drift.

Part 3: Miscellaneous Information

Terms and Definitions

agronomic - Activities relating to field crop production and soil management. "agronomic rate" as related to land application means the amount of water or nutrients that can be utilized by a crop over time.

beneficial use - Any of the various uses which may be made of the waters of Idaho including, but not limited to, domestic water supplies, industrial water supplies, agricultural water supplies, navigation, recreation in and on the water, wildlife habitat, and aesthetics.

BOD_5 (Biochemical Oxygen Demand) - A measure of the dissolved oxygen in 15
wastewater used by microorganism in the biochemical oxidation of organic

matter over a 5 day period. It is often used to determine the efficiency of wastewater treatment facilities.

centibar - A unit of pressure equal to 1/100th of a bar (1 bar = 10^6 dynes per square centimeter). In soil monitoring, a measurement of soil moisture with decreasing values corresponding to increasing soil moisture.

COD (Chemical Oxygen Demand) - A measure of the oxygen-consuming capacity of inorganic and organic matter present in water or wastewater.

DEQ - The Idaho Department of Health and Welfare acting through the Division of Environmental Quality (DEQ).

lysimeter - A device for measuring and collecting the water percolating through soil.

nutrient - Chemicals such as nitrogen, potassium and phosphorus that are needed by plants in the soil for satisfactory plant and crop growth.

TDS (Total Dissolved Solids) - Small solid particles in water or wastewater (generally 1 micron or less in diameter) that are not removed by filtering or settling.

tensiometer - An instrument for measuring moisture content of soil.

TKN (Total Kjeldahl Nitrogen) - The nitrogen content of a material that is analyzed by a Kjeldahl method. This method measures the sum of free ammonia plus organic nitrogen.

TSS (Total Suspended Solids) - Solids in water or wastewater (generally 1 micron or more in diameter) that can be removed by filtering or settling.
uptake rate - The amount of water or nutrients used by plants over time.

vadose zone - The unsaturated area in the soil above the water table.

Wastewater Land Application Permit Program

Wastewater land application in Idaho is regulated by state law and is administered by the Division of Environmental Quality through a permit. This Wastewater Land Application Permit (WLAP) sets forth the general requirements as well as the site specific requirements for each permitted facility. Presently, Idaho has over 100 permitted wastewater land application sites.

An application for WLAP may be obtained through the DEQ regional office in Coeur d'Alene. Prior to submittal of the application packet, applicants are encouraged to schedule a pre-application meeting with DEQ staff. An initial application for a permit can take six months to process through the regulatory and administrative steps. Permits are issued for a five year period and are renewable.

Additional Information Sources

Wastewater Land Application Permit Program:

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1410 N. Hilton
Boise, Idaho 83706
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Editor's Note: These contacts have been updated for December, 2005.

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